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THE JOURNAL OF ENGINEERING EDUCATION

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GIVING ADVICE TO SENIORS.

BY A. A. POTTER,

President of the S. P. E. E. and Dean of Engineering, Purdue University.

We engineering teachers have the great responsibility of guiding our students and particularly those who are about to graduate and to take their places in industry.

Are we assisting our senior students in making an inventory of those things they should be and should have because of their engineering training? Do they realize the importance of character in determining their success in life? Do they appreciate the fact that their mind will keep on growing as long as they exercise it, or do they look on Commencement as the end and not the beginning of study? Do they recognize that the most successful people owe their positions in life mainly to hard work, or are they looking for an easy job? Are they striving to develop such traits of personality that people will enjoy associating with them, or will they limit their advancement by a poor personality, by such handicaps as poor address, awkwardness, self-consciousness, indifference, conceit, or indecision? Do they realize the importance of friends and do they know how to find, make and keep friends? Has their college education assisted them in developing their æsthetic tastes, with the joys of appreciation of the best? Are they capable of using their leisure time advantageously to themselves and to others? Has their educational equipment prepared them for responsible citizenship and have they sufficient vision to utilize their knowledge for the benefit of society, or are they narrow minded and unable to detect the fallacies of the propagandist?

Are we giving our senior students proper assistance in deciding upon their careers? Do they realize that a person is happiest when in an occupation which suits his inherent abil-

ity and personality? Do they appreciate the fact that service, the objective of every worth-while career, is to be considered in the light of one's talents and interests together with the opportunities offered for the assumption of responsibility? It is not what the young man thinks he would like to do but what he is fitted to do that will determine his success. The senior student must also realize that in the engineering profession greatness is measured less in money and more in service and accomplishment.

Are not many of our young graduates sacrificing their future through impatience or by accepting positions which pay well but in which they gain too little experience in preparation for greater responsibilities? Do they realize the importance of gaining their practical experience while they are young and the difficulty of securing a variety of experience after one has dependents? Are they aware of the fact that a college education does not guarantee success, but that their future depends upon their ability to do every task better than the average, upon the use they make of their knowledge and upon the pains they take with their work and their preparation?

Are we encouraging the more gifted of our senior students to prepare themselves by graduate study for teaching or for research careers in connection with which they may have an opportunity to lay the foundations for future engineering progress, to do constructive and enduring work of vital importance to humanity?

Our students about to graduate must be impressed with the fact that they have had educational advantages which should have developed in them courage to do right, ability to think straight, willingness to work hard, personality to make them acceptable to their fellowmen, disposition to make friends, æsthetic tastes to enjoy the beautiful, and breadth of vision to take their place as citizens in their communities.

THE PRESENT STATE OF THE SOCIETY'S INVESTIGATION OF ENGINEERING EDUCATION.

H. P. HAMMOND,
Associate Director.

The following brief report gives a summary of the state of the work in the various projects which are being carried out in the Society's investigation. It is published with the purpose of keeping those who are engaged in the work, and others who are interested in it, in touch with the progress which is being made, and so that the coöperative agencies may keep pace with the work as it advances.

Projects Undertaken by Coöperative Committees of the Faculties.

At the date of writing (February 20, 1925) 110 institutions are participating in the investigation and have appointed faculty committees. The following institutions have appointed committees since the publication of the last list in the January number of the Journal:

Name of Institution.	Chairman of Committee.
Clemson Agricultural College, Clemson College, South Carolina	Director S. B. Earle
Columbia University, New York City	Professor J. K. Finch
Duke University (Trinity College), Durham, North Carolina	Dean W. H. Wannamaker
Lowell Textile School, Lowell, Massachusetts	President Charles H. Eames
North Carolina, University of, Chapel Hill, North Carolina	Dean G. M. Braune
North Dakota Agricultural College, Agricultural College, North Dakota	Dean E. S. Keene
Notre Dame, University of, Notre Dame, Indiana	Professor J. A. Caparo

South Carolina, University of ..... Professor P. M. Teeple
Columbia, South Carolina
South Dakota State School of Mines ..... Professor W. B. Wendt
Rapid City, South Dakota

The number of committees which have undertaken various parts of the program is as follows:

Aa1—A Study of Entering Students	42
Aa2—A Study of Admissions and Eliminations	66
*Aa3—A Study of Students Other Than Freshmen	3
Aa4—A Study of Graduates and Non-Graduates	44
Ab1—A Study of Teaching Personnel (Part 1)	63
A Study of Teaching Personnel (Part 2)	27
*Ac1—A Study of the Services and Facilities of the Engineering Colleges	3
Da3—Experiments with Placement Examinations	12
Da4—Diagnostic Study of Cases of Impending Failure	5

Special studies not covered by the foregoing list are in progress, or have been submitted for consideration of faculty committees in the following institutions:

Case School of Applied Science
University of Cincinnati
University of Wisconsin
Carnegie Institute of Technology
North Carolina State College
of Agriculture and Engineering
The Ohio State University
Tufts College
University of Washington
Harvard University
Lehigh University

Reports have been received from committees as follows:

Aa1—Form 1C—17 reports; covering 2,459 individual entering students.

Aa2—Form 2A—51 reports.

Form 2B—41 reports; covering the admission of 8,559 freshmen.

Form 2C—26 reports; covering eliminations from among 69,538 students with statements of the causes of eliminations of 3,530 students.

* These studies have not as yet been sent to any considerable number of committees.

Form 2F—6 reports.
Aa4—21 reports; tabulating returns from 691 graduates and non-graduates.
Da3—6 reports.

These statements indicate that the colleges have responded generously in the fact-gathering stage of the undertaking to which the present year is being largely devoted. It may also be seen that the information is being supplied to the headquarters office in good time and in good volume.

Some of the more significant facts gathered from a preliminary examination of returns already received will be given in another article in the present number of the JOURNAL.

Two projects which will eventually be submitted to cooperative committees have not as yet been sent to the committees in full. These are Studies Ab1, which deals with the problems relating to teaching staffs, and Ac1, which deals with the services which engineering colleges are rendering to the community and their educational facilities. It has been considered advisable to delay these particular studies until those now in progress have reached a more advanced stage. Outlines and forms for these studies are ready and will be sent to any committee which desires to receive them at the present time.

It is earnestly requested that committees which have studies nearly completed arrange to bring them to a state of completion and submit the data to the headquarters office at the earliest possible date. Those which desire triplicate copies of the forms for submitting returns for any study may receive them by applying to the Director of Investigation, Room 1607, 33 West 39th Street, New York City.

COMMITTEES REQUESTED NOT TO COMMUNICATE WITH OTHER COMMITTEES.

In view of the large number of affiliated committees and of the amount of work involved in studies already undertaken, it is requested that committees do not communicate with each

other or send out requests for information without first submitting the matter to the headquarters office. It will be readily appreciated that if this were done by any considerable number of committees there would be unnecessary duplication of effort. Committees which desire to obtain data other than that contained in projects sent from the headquarters office should communicate with the Associate Director of the Investigation, who will endeavor to supply the information or to point out where it may be obtained.

Projects under the Direction of the United States Bureau of Education.

The United States Bureau of Education has received detailed analyses of engineering curricula from approximately 50 institutions. These are now being tabulated and arranged in form for purposes of comparison. It is expected that a preliminary report on 25 of these institutions will be issued within thirty days. This will be in the nature of a progress report. A similar report will follow on 25 additional institutions. More detailed analyses than those given in the progress reports will follow at later dates. Institutions which have received tabulations relating to analyses of curricula from the Bureau of Education for verification should return them to the Bureau at the earliest possible date.

Surveys of Occupational Demand for Engineering Graduates.

The National Industrial Conference Board has recently completed and published reports on the demand for engineering graduates in the following three industries—paper and pulp, textiles, and rubber. A fourth report on the metal trades industries is now in the hands of the printer and will be issued shortly. Copies of these reports may be obtained upon application and payment of a nominal charge to the National Industrial Conference Board, 247 Park Avenue,

New York City. Communications should be addressed to Mr. A. C. Jewett.

Studies Conducted by the Engineering Societies.

The invitation to participate in the investigation by formulating answers to eight specific questions (see report of the Director of Investigation to the Board of Investigation and Coördination in the Journal of Engineering Education for January, 1925) has been accepted by each of the four Founder Societies and the project is now in the hands of committees which are dealing with it.

The invitation which was addressed to other national engineering societies has been accepted by a number of them and the work is now in progress.

Studies and Projects in Educational Psychology.

Project Da3—Experiments in Placement Examinations—has been undertaken by 12 institutions and the examinations have been given to approximately 2,000 entering students. A request for the scores in these examinations and corresponding first term college grades has been issued to coöperating colleges and the data are now being received. It is expected that the results of these tests will be analyzed and published.

The diagnostic study of cases of impending failures is in progress in five institutions. Results will not be available until after the end of the present academic year.

Investigations in European Countries.

Mr. Wickenden is actively engaged in the European studies and has visited institutions and made studies in France, Belgium and Great Britain. He will pursue his studies in Italy, Germany, Czecho-Slovakia and the Scandinavian countries.

THE PREPARATION, ADMISSION, AND ELIMINATION OF ENGINEERING STUDENTS.

BY H. P. HAMMOND,

Associate Director of Investigation.

(Sufficient data have been received from the Faculty Committees of institutions which are participating in the Society's investigation of engineering education to permit the preparation of preliminary summaries in certain of the studies which are in progress. These summaries are not final, since a number of committees which have signified that they have the work in progress have not submitted reports, but the data in hand are sufficient to furnish the basis of a preliminary survey and partial analysis of the facts. It is expected that more complete reports will be presented at the annual convention of the Society at Schenectady, N. Y., June 17–20, 1925. All figures which are given in the following paragraphs are subject to change as additional returns are received. It is not expected that such changes will be of any considerable magnitude. Studies in which the most nearly complete returns are available are projects Aa1 and Aa2 which relate respectively to entering students and to the matter of admissions and eliminations. The following summary of the situation relative to admissions and eliminations is based upon the results of those studies. This summary is in the nature of a progress report.

Institutions which have not participated in the collection of the data upon which this paper is based may find it valuable to prepare the data so as to permit comparison with the experience of other institutions. Forms for the purpose will be furnished upon request.

Figures given in portions of the article which are quoted from opinions expressed by members of the faculties as to the quality of preparation have not been verified.)

METHODS OF ADMISSION.

Admission to engineering courses in the United States is based almost universally upon the presentation of fifteen entrance units from "accredited" high schools. On the average eight or nine of these units must be in prescribed subjects. These are commonly specified as follows: three units of Eng

lish, three units of mathematics, and two or three units in history, science, or languages. The remaining units may be from an extensive list of options. Few institutions require more than eleven units in prescribed subjects. A few require from but two to five such units and permit selection from a list of options for the remainder. The requirement in mathematics is usually two units of algebra and one unit of plane geometry, or one and one half units of algebra, one unit of plane geometry, and one half unit of solid geometry. Of 110 institutions studied, 64 require solid geometry and 16 require plane trigonometry. Fifty-three of the 110 institutions require two or more units of languages, 78 require one or more units of history, and 69 require one or more units in science, though but 29 definitely prescribe physics and but 11 definitely prescribe chemistry.

A very small number of institutions *require* the candidate to pass the College Entrance Examinations Board examinations or to take entrance examinations prepared by the institution itself, though a majority *permit* students to enter by these methods.

Approximately two thirds of the institutions state that they have full control over entrance requirements. The remainder are obliged by law or by regulation of the State Department of Education to admit all graduates of "accredited" high schools of the state who apply for admission. In a majority of the institutions, requirements for admission to engineering courses differ from those to general academic courses;—the difference being chiefly in the requirement in mathematics. In a few schools the entrance requirements to all undergraduate departments are the same.

Entrance Conditions.

Based upon data covering the admission in 1924 of approximately 4,800 students to 41 institutions of all types situated in all parts of the country, it is found that slightly more than 1,300 of these students were admitted to engineering

courses with entrance conditions. This number does not include students who were first registered in other courses and later transferred to engineering after removal of entrance conditions. It is not possible to state the number of such cases but it is known to be large in a number of colleges. Students were admitted with entrance conditions in various subjects as follows: 900 in mathematics, 200 in science, 175 in languages, 50 in English, and 30 in optional subjects. But 23 of the institutions included among those supplying this information have a prescribed requirement in science, and but 12 have a prescribed requirement in languages. One institution which admitted 374 students to engineering courses in 1924 accepted 227 with entrance conditions;—212 of these having conditions in mathematics. This institution is required by law to admit all graduates of "accredited" high schools within the state who apply for admission.

Quality of Preparation.

In answer to questions submitted to committees requesting the views of members of their faculties as to the quality of preparation to-day as compared with that of ten years ago, and as to means of dealing with those defectively prepared, some very interesting, not to say *illuminating*, replies have been received. As might be expected, opinions and methods in this connection vary considerably. A very few institutions express satisfaction with the quality of preparation. Some believe that the last ten years have brought well-defined improvement. A considerable number note a progressive change for the worse. Many are emphatic in stating the quality of preparation to be seriously defective for students of engineering. The most serious defects in preparation are in mathematics (particularly in algebra) and in English. The following quotations are typical of replies received in answer to the questions mentioned. These replies are not only indicative of opinions as to quality of preparation, but

mention some of the methods in use for dealing with the situation.

In connection with the quality of preparation it is to be noted that slightly over one half the students admitted to engineering courses in the fall of 1924 were honor students in high school or were in the upper third of their classes. Approximately 85 per cent. of the students who enter engineering courses receive their preparation in public high schools. The balance prepare in private preparatory schools, parochial schools, by private tutoring, etc.

The experience is common that students are seriously lacking in elementary training, as in grammar and mathematics. There is much evidence of a lack of drill and mental discipline. They seem untrained in "digging things out." Since 1917 the per cent. of total freshmen enrolled in special classes for those of insufficient training in algebra has increased as follows: 10, 16, 27, 30, 31. Last year 29 per cent. of freshmen had to be sectioned to special classes because of poor English preparation and already this semester this is true of 21 per cent. with more to follow. Because of the growing number of high schools which offer but one year of algebra the Engineering School last year made the requirement that all freshmen must take five hours of college algebra.

All this tends to a slowing up of the educational process. More advanced courses are sometimes handicapped by the student's immaturity or acquaintance with these fundamental things and his lack of "background."

An analysis of faculty opinion submitted in writing indicates that, in general, it is felt that students are not as well prepared at the present time as they were ten years ago, which is attributed to two reasons: First, the crowded conditions in the high schools and the elaboration of the high school curricula and, second, the fact that a larger number of high school students are coming to college, which tends to lower the average of ability.

The poorer preparation of engineering students is felt principally in the mathematics courses and more time is required for review and drill than formerly. Other members of the faculty report less ability than formerly on the part of the students in attacking and carrying through to solution prob-

lems requiring close thinking. Students, apparently, have not acquired good habits of work and the college instructors are obliged to devote considerable time to teaching the students how to study and helping them to cultivate habits of thoroughness and accuracy.

The requirement for entrance to the College of Engineering has been and is *one and one half units* of algebra; however, students have been and are allowed to enter with *only one unit* of algebra.

Students entering the Engineering College are not as well prepared in algebra now as they were ten years ago, or twenty years ago.

On account of the relatively higher wages of the poorer classes, it is possible for every child to attend High School. The percentage of eighth-grade graduates that enter High School has increased from 15 per cent. to 90 per cent. The High School, therefore, has no longer a naturally selected group of pupils, but accepts practically all of the eighth grade. In order to be able to graduate nearly all of them at the end of four years, the High School has "broadened its curriculum." Simpler texts in algebra have been sought, "combined courses" have been written, the course has been broadened to contain many interesting and so-called practical things, and many of the difficult parts have been omitted. This "enrichment" of the curriculum applies to nearly all High School studies and has grown to such an extent that graduates have a superficial smattering of many subjects. The main defect, however, is that they have never seriously studied anything enough to know that one thing well, and consequently, have not developed the ability to study at all. It has become fashionable to attend High School; it has been made pleasant to attend High School and one who does not attend is ostracised. This is not intended as a criticism of the High School. The High School has its own problems and is attempting the best possible solutions.

Some years ago students were held to a more or less rigorous training in the elements of algebra and geometry. This has been replaced by a more or less superficial study of the elementary parts of a considerably wider range of mathematics. While this latter may be good or better for the general student, it is an impossible course for an Engineering student. The Engineering student must begin at the beginning again.

He must learn the fundamentals of algebra, *instead of learning to solve easy problems by imitative methods.** A few High Schools of the State sometimes have teachers who realize that an Engineer must know fundamental algebra.

In order to connect the work of the High School in mathematics with the work of the Department of Mathematics and Mechanics of the College of Engineering, the following plan has been in operation for several years.

All entering students whether they present one, or one and one half units in algebra are placed in the same class for twenty lessons in review algebra. The text in use this year is Hall and Knight's "Algebra for Colleges and Schools," revised by Sevenoak; and the twenty lessons covered the first 240 pages. In assigning lessons, students were urged to study the text, to work the last 3 or 5 problems in each list, to omit the easy imitative problems and solve the literal ones. A written quiz, or test of preparation, was given each day at the beginning of the period. At the end of twenty lessons, a final examination was given to all at the same time. The examination occupied 2¾ hours and was composed of 17 problems from the text, each of which correctly solved counted six points—no partial credit was given for any problem. Grades were made up by weighting daily work including daily quizzes, two, and the examination, one.

The results of such procedure for the past two years show as follows:

	If the Passing Grade Were 70 Per Cent.	If the Passing Grade Were 60 Per Cent.	If the Passing Grade Were 50 Per Cent.
Oct. 1923. Out of 400 students...	100 pass	200 pass	250 pass
Oct. 1924. Out of 400 students...	40 pass	100 pass	200 pass

On the basis as outlined the class is divided: those who pass continue for the remainder of the quarter in College algebra (same text, p. 240 to end, with some topics omitted); those who do not pass begin at the beginning of the same text and work the same first 240 pages for the remainder of the quarter (without University credit). Necessarily, the latter students fall behind one quarter and provision is made for these stu-

* Italics by the author.

dents to make up their deficiency during the following summer quarter.

Commenting further upon the topic of preparation of entering students, I give it as my opinion that the unquestionable lack of preparation is due in very large measure to the multiplicity of subjects in the secondary schools from which entrance units may be chosen and to the lack of proper guidance of students who expect to prepare for college in the selection of subjects to be studied. The function of the High School, as I see the matter, is twofold; to prepare for college and to prepare for lifework. Approximately 90 per cent. of High School graduates do not go to college. Unquestionably, then, the high schools devote in their curricula major attention to the needs of these students. But in doing so the 10 per cent. should not be lost sight of, which now seems to be the case. In other words, there seems to be no differentiation made in the selection of subjects for the 10 per cent. and the 90 per cent. The result is that the 10 per cent. are allowed to pursue subjects, while good in themselves and excellently adapted to the aims of the 90 per cent., have no real intrinsic worth as preparation for subjects to be pursued later in college. Obviously, such subjects as agriculture, horticulture, home economics, bookkeeping, shorthand, typewriting, and the present mania for physical education have little relation to the preparation necessary for work to be done later in college; but the greatest harm accrues when the student who expects to go to college is permitted to take these subjects to the exclusion of those that would give him better or at least more adequate preparation.

Some of the methods of dealing with unsatisfactorily prepared students are mentioned in the foregoing quotations. The most common practice is to provide courses of sub-collegiate type which carry no college credit. In a number of schools private tutoring sections are formed. Some schools make no definite provision for defectively prepared students and leave it to the student to remove his entrance conditions as best he may. Some institutions give credit for entrance conditions if satisfactory work is done in corresponding college subjects. Most of the colleges require that entrance conditions be removed before the beginning of the sophomore year.

A few permit students to carry entrance conditions until the beginning of the junior year. In several institutions it is the practice not to admit students to engineering courses who do not satisfy the entrance requirements; but such students are registered in other courses, whose requirements they fulfill, and are later transferred to engineering when the entrance conditions are removed.

Choice of Career and of College Course.

The average age of students who enter engineering courses is 18 years and 9 months. A decision to become engineers is reached by approximately 55 per cent. of engineering students before they reach the last year of high school—at an age of 17 years and 6 months, or earlier. Slightly more than 85 per cent. of engineering students definitely choose a particular field and course in engineering before entering college. Although less than one fifth of the colleges require a selection of course at time of entrance, the great majority of students make such a choice before entering college and comparatively few change their decisions after entering. Nevertheless, less than 50 per cent. of freshmen after from one to four months of a college course are able to give other than a vague and ill-founded statement as to the scope of engineering and the work of an engineer—nor do they (as far as the evidence is available from the present studies) have any adequate conception of the particular field of engineering which they have decided to enter. That there is a great need for sound advice to high school students in choosing careers is obvious, and it may be that the engineering colleges can assist high schools in furnishing students who contemplate taking an engineering course with the facts regarding engineering as a life work.

The Result—Eliminations.

While the elimination of students from engineering courses is undoubtedly due to a combination of many factors, it seems clear that present methods of admission and the lack of valid

vocational guidance of high school boys is to a considerable extent responsible for the very large shrinkage in classes pursuing engineering courses. Based upon the records of approximately 70,000 students admitted during the past 22 years it is found that for every 100 students admitted, 40 were graduated. The number of graduates includes men who required more than the normal period for the completion of their courses and also includes those admitted in advanced standing. The general tendency of the elimination ratio shows a gradual increase, though the increase is not especially large except during the abnormal conditions of the war period. At the present time, on the average, of every 100 students who enter regularly and pursue regular courses, 62 begin the sophomore year, 43 begin the junior year, 33 begin the senior year and 30 graduate regularly with their class. The difference between the two figures (40 and 30) given for the number of students graduating is due to those who require more than the normal period to complete their course and to men admitted in advanced standing by transfer from other institutions or from other courses in the same institution. These figures are based upon returns from various types of institutions in all sections of the country.

As might be expected there is considerable variation in the elimination ratio between various institutions. Some colleges which offer the customary four-year course have regularly eliminated 85 per cent. of students who entered. The lowest elimination ratio for engineering courses thus far received is approximately 40 per cent. This particular institution has a small engineering department and a highly developed system of selective admissions, since the number of applicants is several times the number of students admitted. With a few exceptions, the larger schools have elimination ratios quite close to the average experience.

Causes of Eliminations.

Twenty institutions of various types situated in different parts of the country have furnished detailed statements of the

causes of eliminations. The principal causes and the number of cases attributed by the institutions to each are as follows:

Causes.	Number of Cases.	Per Cent. of Total
Scholastic failure	1,810	48.4
Health of student	172	4.6
Voluntary change of course of institution	541	14.4
Financial difficulty	215	5.7
Dismissal for cheating or other improper conduct	83	2.2
Change of status of student's family	51	1.4
Miscellaneous causes not above enumerated	50	1.4
Unknown causes	822	21.9
Totals	3,744	100.0

It is to be noted that the number of cases definitely attributable to scholastic difficulty is nearly 50 per cent. of the total. It is highly probable that a certain proportion of students who changed course or institution voluntarily were not in satisfactory scholastic standing, and it is no doubt true that among the 21.9 per cent. of cases having unknown causes there are many who left because of scholastic failure or the likelihood of such failure in the future. On the whole it is probably not far from the truth to state that from 55 to 60 per cent. of all cases of elimination of engineering students are due primarily to failure in scholastic work.

As stated in a former number of the JOURNAL studies are in progress with the purpose of ascertaining the more fundamental causes of scholastic failures and eliminations. The results of these studies are not as yet available but will be published in due course.

The foregoing facts speak largely for themselves. The question now is "What is to be done about it?"

It has been stated many times that the Society's investigation is a strictly coöperative undertaking. It is the purpose to place in the hands of the engineering colleges and their

faculties the coördinated information from many schools which may serve as a guide to the adoption of intelligent steps for improvement. Solution of the problems of engineering education rests with the individual institutions and with the individual teachers. It is earnestly hoped that the readers of this article will send to the Headquarters Office (Society for the Promotion of Engineering Education, Room 1607, 33 West 39th Street, New York City) constructive opinions and discussions of the situation set forth in this article.

PRELIMINARY PROGRAM OF THE THIRTY-THIRD ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

UNION COLLEGE, SCHENECTADY, N. Y., TUESDAY, JUNE 16, TO SATURDAY, JUNE 20, 1925. A. A. POTTER, PRESIDENT.

Tuesday, June 16, 1925.

2:00 P.M. Conference on Research: The United States Bureau of Standards, The General Electric Company, The Society for the Promotion of Engineering Education. (To be arranged by President Potter.)

6:30 P.M. Dinner for this group.

7:30 P.M. Meeting of the Board of Investigation and Coordination. Chas. F. Scott, Yale University, *Chairman.*

Wednesday, June 17, 1925.

10:00 A.M. Meeting of the Division of Deans and Administrative Officers. H. S. Boardman, University of Maine, *Chairman.* (All day session.)

12:30 P.M. Conference of teachers of Electrical Engineering. H. E. Dyche, University of Pittsburgh, *Chairman.* Research as an Aid to Teaching. Inspection of laboratories of General Electric Company.

2:00 P.M. Conference of Teachers of English. J. Raleigh Nelson, University of Michigan, *Chairman.*

Conference of Teachers of Industrial Engineering. J. W. Roe, New York University, *Chairman.*

6:30 P.M. Dinner Meeting of the Council.

PRELIMINARY PROGRAM OF ANNUAL MEETING.

Thursday, June 18, 1925.

7:30 A.M. Breakfast Meeting of the Council.

10:00 A.M. Opening Session.

Address of Welcome, Charles A. Richmond, President of Union College.

Response to Address of Welcome, A. A. Potter, President of the Society and Dean, Schools of Engineering, Purdue University.

Report of the Board of Investigation and Coordination. Charles F. Scott, *Chairman.* W. E. Wickenden, Director of Investigations, H. P. Hammond, Associate Director. (All day meeting devoted to this subject.)

12:30 P.M. Luncheon Meeting of the Council.

2:00 P.M. Second Session.

Discussion of the Report of the Board of Investigation and Coördination.

8:00 P.M. Round Table.

Friday, June 19, 1925.

7:30 A.M. Breakfast Meeting of the Board of Investigation and Coördination.

9:30 A.M. Meeting of the Institutional Delegates. G. B. Pegram, Columbia University, *Chairman.*

10:30 A.M. Third Session.

12:30 P.M. Luncheon Meeting of the Council.

2:30 P.M. Fourth Session.

7:00 P.M. Annual Dinner.

President's Address: The Engineering College—Its Opportunity for Service. A. A. Potter, Dean, Schools of Engineering, Purdue University; President of the Society.

PRELIMINARY PROGRAM OF ANNUAL MEETING.

Saturday, June 20, 1925.

7:30 A.M. Breakfast Meeting of the Council.
7:30 A.M. Breakfast Meeting of the Teachers of English.
9:00 A.M. Fifth Session.
1:00 P.M. Luncheon Meeting of the Board of Investigation and Coördination. Chas. F. Scott, *Chairman.*

FIFTEEN YEARS OF EXPERIENCE WITH A FIVE-YEAR ENGINEEING CURRICULUM AT NORTHWESTERN UNIVERSITY.

BY W. H. BURGER AND JOHN F. HAYFORD.

The College of Engineering at Northwestern University has had 15 years of experience in giving a five-year engineering course. This paper is an attempt to state clearly the ideals of this particular five-year program, to indicate in concrete form the ways in which the College has attempted to carry out these ideals and to state the Northwestern views as to the special values of this particular type of engineering education. The attempt is made to concentrate the thoughts of past years of the engineering faculty and to set forth their present opinions.

The motto of the College of Engineering of Northwestern University is "Culture for Usefulness." This motto calls for an effort to obtain for the student the broadest culture attainable in five years in order to equip him, as a man and as an engineer, for the greatest possible usefulness in the world in the united struggle of man for progress. The College aims to train future engineers for the greatest average effectiveness in a lifetime rather than for the greatest effectiveness in the first year after graduation. It aims to develop a capacity for unlimited growth. The College is concerned not only with the immediate and obvious necessities but also with the more intangible and faraway, finer, things of life.

It is believed that in developing a curriculum, and especially in developing the methods of teaching used in connection with that curriculum, it is very important to consider what habit of thought is apt to be produced in the student. One of the most important things a man may secure from his college education is such a habit of thought as will make him effective in the work of the world and will enable him to enjoy life.

FIVE-YEAR ENGINEERING CURRICULUM.

The two curricula, one in mechanical and electrical engineering and one in civil engineering, are shown in Appendix A of this paper in the form in which they are now given. Only slight modifications have been made during the fifteen years since the College was established in 1909.

Certain of the peculiarities of the type of education represented by these two curricula must be emphasized to enable one to appreciate and value it. One must also know the controlling ideas of those who teach the various courses which make up a curriculum, if one is to secure a sound evaluation of the resulting education.

In studying these curricula, note that the engineering training in the narrow sense commences in the freshman year and continues throughout each of the five years, occupying a large portion of the curriculum in the last two years and a relatively small portion in the first three. The general education, represented by the courses normally given in a college of liberal arts, extends throughout all of the five years. This arrangement is based upon the idea that a liberal arts education is an essentially inseparable part of an engineering education,—not a matter separate and apart, to be secured first. The liberal arts portion of the education is in part a basis for the engineering training, and it is in part essential to fit the engineering student into the world's work, to enable him to use his technical knowledge effectively, and to live a richer and more contented life. If the student sees that his liberal education is an essential part of his engineering education he is more apt to secure such a comprehensive knowledge of men and their thoughts as will tend to lead him to positions of responsibility. The embryo engineer should be trained in high ideals of public service and for public service. These are some of the thoughts which led to wiping out all lines of separation between liberal arts education and engineering education at the College of Engineering at Northwestern.

At Northwestern the engineering student registers in the College of Engineering from the beginning as a freshman. He takes the courses in liberal arts and engineering under

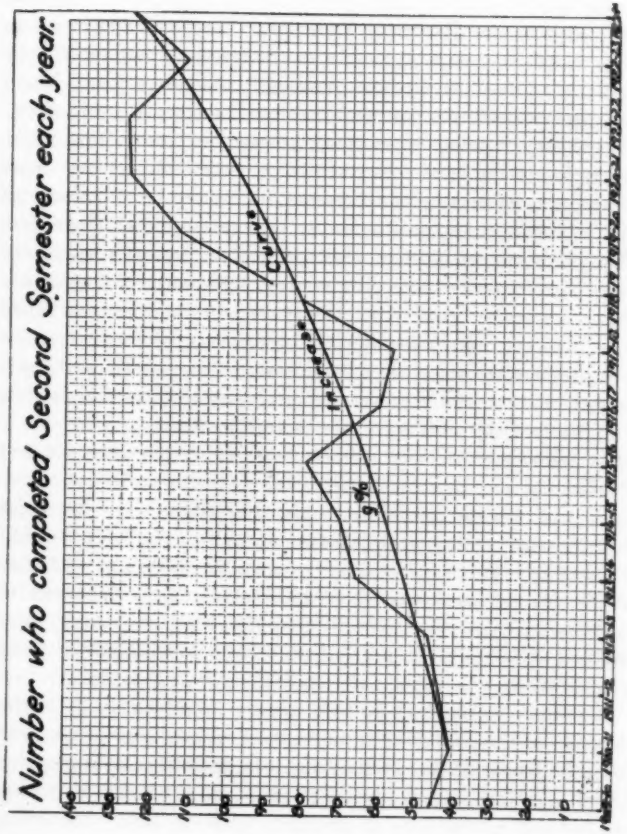
the continuous control of the engineering faculty. The engineering students are merged with the liberal arts students in class rooms, and in campus, social and athletic activities. It is believed that this control from the start by the engineering faculty, combined with the close contact with the liberal arts faculty and with students having other ambitions that his own gives the engineering student early orientation and unusual breadth of view.

Each engineering student is required to secure the equivalent of three periods of six weeks each of practical experience of such a character as to be of value to him as a prospective engineer. This is the Northwestern application of the cooperative idea in engineering education.

It is believed to be important to the student to develop the ability to talk convincingly to an audience. In some of the courses of the senior and fifth years a special effort is made along this line and the success secured seems to be out of proportion to the moderate time devoted to the effort. At that stage in his development the student has come to see that ability to hold the attention of an audience by speaking in a convincing way is valuable to him.

One of the basic principles of real education is that it is important to maintain continuous thought over long periods, long sequences. A much poorer education comes from the taking of a number of different subjects, studying them for a short time and then dropping them. This discontinuity is the fundamental fault with the elective system, which makes in general for studies in many different fields, in each one for a time only. The Northwestern five-year engineering curriculum, which is nearly all rigidly prescribed, is built up along lines of sustained thought more fully than is possible in the ordinary four-year engineering course.

Note that in each curriculum 15 or 17 hours of electives, about 10 per cent. of the total, are required. These are restricted to subjects given in the College of Liberal Arts, School of Commerce or School of Speech. The student is not allowed to take these electives in engineering subjects. They are


Number who completed Second Semester each year
Class of 1909
Class of 1910
Class of 1911
140
130
120
110
100
90
80
70
60
50
40
30
20
10

normally taken in the fourth and fifth years. The student at that time is found to make a wise choice as a rule. There has been an improvement year after year in this respect.

No special curricula are offered at the College of Engineering, such as for Railroad, Sanitary, Telephone Engineering, etc. Northwestern stands firm in the thought that the fundamentals of engineering are practically the same in all lines; that specialization is best deferred until a man is in his work; that theory, a true understanding, may be taught most effectively in college; and that so-called practical things may most effectively be learned outside the college walls. It may be that Northwestern graduates in engineering find their first few years out of college slightly harder than the graduates from specialized engineering courses who happen to get into their particular specialty. On the other hand it is believed that the firm foundation supplied by the more thorough training in the fundamentals of engineering, combined with general education of the man, makes the latter progress farther and faster than would be otherwise the case.

In following the Northwestern engineering course a student studies the engineering subjects later in the course as a rule and with better preliminary training than in a four-year engineering course. Note for example that Structural Mechanics is given in the fourth year after the student has had two years of mathematics and is taking his third year of physics. Under these conditions, the students being more mature and with a better scholastic foundation, a higher grade of engineering course may be and is given with success.

Entrance to the College is in general on the basis of certificates from high schools. This method, in common with others, admits many who do not continue long in college. The curriculum as administered, however, soon weeds out the weaker students, the unfit, the unprepared, and the lazy. Good students who are inclined to other lines of college work usually transfer early. The mortality up to the beginning of the fourth year is about 40 per cent. or more per year.

The curriculum demands full use of the energies of the stu-

dents. The graduate of the College of Engineering has ordinarily accomplished in five years the equivalent of about six years of a liberal arts course. At a matter of experience, however, it is found that this harder and fuller course taken by the engineers does not prevent them from doing their full part in student activities and in athletics and in getting a reasonably good all-around development.

All of the requirements for the Bachelor of Science degree, as defined by the College of Liberal Arts, are included within each of the engineering curricula. The student of engineering normally receives the Bachelor of Science degree (without any engineering subscript) on the recommendation of the faculty of the College of Liberal Arts at the end of his fourth college year.

One of the aims of the College of Engineering at Northwestern has been to secure as many select men as possible, men above the average, who are capable of unusual development as men and as engineers. No feasible method has been found of selecting such men at entrance from the high schools. In practice, however, it has been found that the prescribed five-year curriculum soon makes this selection. The men of small caliber, small ambition or narrow viewpoint soon drop out. Those who stay through to the fourth and fifth years are to a gratifying extent of the type desired.

The record up-to-date of the careers after graduation, of the men who secured the Bachelor of Science degree while registered in engineering but did not remain for the engineering degree, indicates that their four years of education has been effective development.

The average mark for each successive year for all students of engineering, and separately for those students who finally secure the engineering degree, is shown in the following table. Note the rapid increase from year to year, about five points on the scale of 100 each year, for all students. This is largely the result of elimination. On the other hand note that those students who finally secure the engineering degree do nearly uniformly good work throughout their course. Note also that

for these students there is a clear tendency for the fourth and fifth years of work to be better than the third year.

AVERAGE MARK.

	For All Students.	For Students who Secured an Engineering Degree.
Freshman Year	65	82
Sophomore Year	71	81
Junior Year	76	77
Senior Year	78	81
Fifth year	83	84

It was clearly seen at the outset that a five-year program with a practically rigidly prescribed curriculum of a type which would rapidly eliminate the unfit would hold down the number of students. At the outset it was decided to put the emphasis on thorough education, on quality first, and not to expect large numbers. As shown by the curves which form Appendix B there has been upon an average an increase of 9 per cent each year over the preceding year, from 1910–1911 to date. The year 1909–10 was abnormal because the entrance requirements as enforced were different from those adopted later. The year 1918–19 (S. A. T. C.) is left out of consideration on account of conditions peculiar to it.

The number of students being small, especially in the fourth and fifth year classes, each student has an exceptional opportunity to get into close touch with members of the engineering faculty. This close contact is also favored by the fact that as a rule the laboratory work in each engineering course is in charge of the same man who carries the class work of that course.

The following shrinkage table indicates clearly the rate of elimination. It should be compared with the statement as to normal marks for all engineering students as given earlier in this paper.

	Shrinkage in One Year as a Percentage.	Number Remaining of 100 Registered at the Beginning of the First Semester of the Freshman Year.
To end of Freshman year	24	76
To end of Sophomore year	47	40
To end of Junior year	40	24
To end of Senior year	46	13
To end of Fifth year	28	9

The total number of engineering degrees granted to date is 45, of which 8 were granted in June 1924.

It is especially important to note that the shrinkage between the fourth and fifth years is less than between any other 2 years. The engineering student who has finished four years and who has secured a Bachelor of Science degree is more apt to remain for one more year than is the student who has finished one of the earlier years. There had been a misgiving early in the history of the College that granting a Bachelor of Science degree at the end of the fourth year might result in the feeling on the part of many men that their college education was finished.

Five of the 45 men who secured an engineering degree also won election to Phi Beta Kappa. This is an indication of the character and quality of the students who were held for the later years of the engineering curriculum.

Graduates of the College of Engineering have as a rule expressed sincere and cordial appreciation of the value of the education received.

The careers of our graduates furnished but a weak test of the value of their engineering education. They are too few in number (45) and their average length of service is too short (4 years). Nevertheless the evidence furnished by a study of the careers of our graduates is decidedly encouraging as indicating that the attempt to train for leadership and for the higher phases of engineering work has been successful. An unusually small percentage of our graduates are in the ordinary routine technical type of engineering (about

40 per cent.). An unusual percentage are already either in the executive part of engineering or in the research side of engineering (over 40 per cent.).

Another objective indication of the success of the Northwestern plan of engineering education is the fact that the engineering faculty has changed but little in the past 12 years. Only one professor has dropped out in that period. The others have stayed with the work continuously and enthusiastically, working as a united team largely because of their belief that they are doing a work especially worth while.

There is no thought in the Northwestern group that perfection has there been attained in engineering education. The largest of all rooms is the room for improvement. In fact one of the motives back of the preparation of this paper was the feeling that a searching review of what we believe has been accomplished, prepared for presentation before such an audience as this, would be likely in itself to furnish suggestions to us for further progress.

A 5-year curriculum is not advocated for all colleges of engineering or all engineering students. For those colleges whose aim is to develop men qualified to take positions among the creative leaders in the engineering profession, we believe that a 4-year curriculum is too short. Less than 4 years may serve to develop the needed technicians in the engineering field.

In preparing this paper there has been no thought of trying to impress the idea that the Northwestern plan is the only solution of the problem of engineering education. The endeavor has been to give you a definite statement of our ideals and of the fundamental peculiarities of our plan, to indicate our judgment as to the strong points of the plan as worked out in operation, and to indicate some of the bases of the judgments expressed. The Northwestern plan may not be the plan to use at other colleges where the conditions and ideals are different. We are strong in the belief that any education for the profession of engineering, whether in 4 years or 5,

should include within itself, as an essential part, a considerable amount of liberal education. This conclusion does not apply to technicians, draftsmen, for example, especially if a plan is devised for training such technicians in less than 4 years.

The Northwestern plan of engineering education is especially well adapted to the man who has a good imagination, who is interested in ideas and who does not need an excessive amount of shop work and other concrete detailed work with materials and apparatus in order to enable him to understand the fundamental principles of engineering. These men with good imaginations are the most promising material for the future creative leaders in the profession of engineering.

APPENDIX A.

COURSES OF STUDY, COLLEGE OF ENGINEERING, NORTHWESTERN UNIVERSITY.

Freshman Year.

Required Studies in Both Courses.	Semester Hours. 1st Sem.	2d Sem.
Mech. Draw., Eng. A1, or Shop Work, Eng. A2....	2	...
Shop Work, Eng. A2, or Mech. Draw., Eng. A1...	...	2
Math., Trig., Coll. Algebra and Analytical Geom..	3 or 5	3 or 5
English A1.....	3	3
French A.....	3	3
Chemistry A.....	4	4
Summer Work.....	...	2

Sophomore Year.

Calculus, Math. B1 and B2.....	3	3
Physics A1.....	4	4
German A.....	3	3
Surveying, Eng. B2.....	3	3
Shop Work, Eng. B1.....	1	1
English B1.....	2	2
Summer Surveying, Eng. B3.....	...	6

FIVE-YEAR ENGINEERING CURRICULUM.

Junior Year.

Physics B	3	3
Descriptive Geom., Kinematics, and Graphical Statics, Eng. C1	3	3
Chemistry B1	5	...
Geology A1	5	...
*Chemistry B2	...	5
*Geology B18	...	4
Economics A	...	5
Summer Work	...	2

APPENDIX A.

COURSES OF STUDY, COLLEGE OF ENGINEERING, NORTHWESTERN UNIVERSITY.

Required Studies, Combined Electrical and Mechanical Engineering.	Semester Hours.		Required Studies, Civil Engineering.	Semester Hours.	
	1st Sem.	2d Sem.		1st Sem.	2d Sem.
Senior Year.			*Senior Year.*		
Physics C1	3	3	Physics C1	3	3
Electrical Eng., Eng. D6	3	3	Structural Mechanics, Eng. D3	3	3
Structural Mechanics, Eng. D3	3	3	Mathematics C1	3	.....
Mathematics C1	3	....	Elective	4	7
Elective	4	7	Electrical Machinery, Eng. D5	3	.....
Journals, Eng. D2	1	1	Heat Engines, Eng. D4	.....	3
Summer Work	.....	2	Journals, Eng. D2	1	1
			Summer Work	.....	2
Fifth Year.			*Fifth Year.*		
Adv. El. Eng., Eng. E5	3	.....	Structures, Eng. E9	5	.....
El. Power Plant Eng., Eng. E6	.....	3	Bridges, Eng. E8	.....	5
Thermodynamics, Eng. E1	4	.....	Hydraulic Eng., Eng. E4	3	3
Engines, Eng. E3	3	3	Railroad Eng., Eng. E10	4	.....
Hydraulic Eng., Eng. E4	3	3	The Public Relations of Engineers, Eng. E2	.....	2
The Public Relations of Engineers, Eng. E2	.....	2	Elective	3	3
Elective	2	2	Thesis, Eng. E7	2	4
Thesis, Eng. E7	2	4			

* The student may omit either Chemistry B2 or the second semester of Geology.

Discussion of "Fifteen Years of Experience with a Five-Year Engineering Curriculum," by John F. Hayford and W. H. Burger.

Anson Marston: I would like to ask if Professor Burger will give us some figures as to the number graduating at Northwestern during the last three or four years.

Professor Burger: We had eight men graduate from the fifth year engineering course this year. The total number of B.S. graduates is thirty-nine, and about fifty per cent. of this number has remained for their engineering degree—a little over fifty. Next year, the fifth year class will have about fifteen men in it.

F. E. Turneaure: I have been interested in the Northwestern plan ever since it was inaugurated. There have been various things in the report we have just heard which makes me wonder which particular feature is the cause of the success of the plan, granting that these graduates have been very successful, perhaps more than the average. I notice first that only nine per cent. of the entering class get through. I am afraid that if we organized our work on the basis of nine per cent. finishing the course, something would happen to the instructors. Such a small percentage is of course, a very highly selective body of students, whether selected unconsciously by the students themselves or of necessity by the instructors in the requirements imposed upon the students; nevertheless, such a close selection is a very effective one in producing the men we would like to see graduate in our institutions. The program of study described is somewhat different from that which was in the mind of the group of Deans of the Mississippi Valley which met one or two years ago and suggested what should probably be the next step in developing engineering education, namely four-year course in which a series of liberal studies should run through the entire period, this to be followed by a fairly well organized fifth-year graduate course. I think it would be the opinion of our own faculty that a more liberal program in regard to its electives

than the Northwestern plan would be desirable. In our courses, there are from twelve to twenty hours elective studies in the Junior and Senior Years, and it has been interesting to watch the development of ideas of the student as to what courses they wanted to take. Most of the free electives are taken in liberal arts. Many students continue with economics, some take political science, and a good many take courses in advanced English and various other things in which they become interested. It is very seldom that these courses are selected haphazard; they are generally chosen on the basis of the interest of the student, and on the whole we believe that this is a very effective way of encouraging the student to become interested in the things outside of his technical work, and to liberalize his ideas. In this respect I believe we differ somewhat from the specific studies. But the Northwestern experiment is certainly a very interesting one and I know that Dean Hayford knows when things are good and when they are not good, and when he undertakes a particular program it is pretty certain to be successful.

G. C. Anthony: Mr. President, it is surprising that we all do as good work as we do, considering the fact that our work varies so greatly in the different schools, judging from these catalogues which Dean Evans has spoken of. I have been a writer of catalogues for a great many years. I write the engineering part of the catalogue of Tufts College, and a good many of the faculty of the engineering school do not understand what I have written. I suppose that may be due to my English, but I think a good deal of it is due to the terminology.

Now, as I looked over the curriculum presented in the Hayford paper, I could not understand it. I found a tremendous amount of physics, physics the first year, the second year, third year, and I believe the fourth. If you will look at the curriculum at Tufts, you will find that there is no physics until the third year. Of course, it appears to be very bad; we all recognize that, but we give a great deal of physics in

the first year under a different name. More physics in the second year, but also under a different name, while the main course in mathematical physics does not occur until the Junior year. Now, such a catalogue statement is very misleading. It has to be explained.

If I had only realized that this matter was coming up, I would like to have prepared a paper, as I expect to do next year, on a six years experience, with a course which is quite different from almost all of the courses now given, and which has created a good deal of enthusiasm on the part of the part of the students and faculty. Let me briefly explain my own ideas regarding it, and I think the faculty are in general agreement with me. I am not interested solely in educating for engineering but in developing men of character, and I believe the engineering school, at least with us, is designed to do that for men who like scientific and engineering things. The curriculum is based pretty largely on the idea, that the man who comes into an engineering school wants an engineering course, and we give it to him the first day when he may have something to do with the running of a dynamo or taking of indicator cards—I know this is heresy—but we do it, and I think with a reasonable degree of success. In other words, he is initiated into certain phases of engineering; he becomes familiar with certain technical things; he comes to know the difference between a crank and piston rod early in his course, and he does know something about the different fields of engineering, which results not infrequently, in some change in his course. He may have taken an engineering course that is not exactly what he supposed it to be and he desires to transfer from electrical engineering to civil engineering, or vice versa. We permit of such a change by allowing considerable freedom in the course for adjustments of that character.

We require a student to pursue a course regularly for three years, with a large number of English electives, which are so arranged as to develop him broadly and, inasmuch as

English is the most popular course in the engineering school, we have no difficulty about election in this department; we do not force the student to take what we used to designate as required electives. By the time he has completed his junior year he has had, under different names, many of the so-called cultural studies, in the department of English. At the end of this three year course, he may specialize to a considerable degree in electricity, mechanical engineering, civil engineering, or he may go Scott Free of the whole and take a course which will give him a Bachelor of Science in Engineering. I don't know that the faculty are in entire accord with me on that, because they fear that too many men are going that way, who have taken three years of engineering work and want a little of economics, sociology, and business science, if we may term it as such, and to them we give great freedom, in election but of course, with the approval of the department.

Later I hope to bring to you some results along this line; but I fancy that after all we are not working so very differently from that which already has been prescribed here.

G. B. Thomas: Dean Turneaure brought out the fact that in testing the effectiveness of the five-year course, consideration had been given only to nine per cent.—that being the percentage of those entering who have completed the five years. I am wondering what study has been made of the progress of the 91 per cent. who dropped out before completing the five years, or of the 87 per cent. who failed to complete the four years.

In our alumni associations all over the country some of the most effective members never received their degrees. In manufacturing, if 91 per cent. of a costly material were rejected at various steps in the process, studies would be made to get better raw material and to improve the process. If the specifications were so rigid as to make such a high percentage of rejection necessary, attention would be given to utilizing this rejected material in by-products.

Now it takes about 18 years to produce a freshman engineering student and it takes several thousand dollars to train

him for four or five years. Should not selection methods and curricula be developed to train a much greater percentage of accepted students than at present? Can not curricula be arranged so that those who have completed one year of training would be recognizably better prepared to enter industry than before taking that year?

After completing the first year, only those who gave promise of being able to profit from a second year's training would be permitted to continue. This second year's training would be such as to qualify men to enter industry better prepared than those who had only one year. Likewise for the third, the fourth and successive years, only those who had satisfactorily completed the preceding year and gave promise of profiting by the succeeding year would be permitted to continue.

At the end of each year those who had not qualified to take up the succeeding year would enter industry as having completed one, two or three units as may be, of a progressively difficult course. Thus, those whose interest or mental endowments enable them to complete only two years of technical training would enter industry, not as having failed at college, but as having finished a recognized training program. Should not study be given to some such a plan so that the greatest percentage of those admitted to engineering courses should be trained to the maximum of their abilities?

D. C. Jackson: I had not intended to enter this discussion, because I have expressed my views so many times on these particular things; but Dean Marston just made a remark to the effect that he would join the other engineering schools on the basis of a five-year course curriculum. I used to preach that doctrine, but farther experience leads me to prefer the the four-year undergraduate curriculum, associated with provisions for graduate work for one or more years, upon which students of approved youth, ambition and ability should be encouraged to enter after securing their bachelor's degree. For this graduate work there should be no set curriculum, but the

provision should be of an ample variety of subjects treated by means of full year courses of rather advanced lectures on theory and research courses in the laboratories and library. It is not wise to permit any graduate student to pursue such substantial courses in more than three or four subjects at one time in addition to a thesis research, which latter should be associated with one of the subjects referred to. In the selection of his subjects and his methods of work, each graduate student in this practice may and should have a large degree of independence, but should be under constant observation and counsel by the faculty. Experience for some years with numerous graduate students treated in the manner described convinces me that the plan is made more fruitful than would be an extension of our formal curricula to a length of five years, at least in those engineering schools where students come to the freshman class with good preparation. I will join heartily with Dean Marston in urging the greater development of such graduate work in our engineering schools but would deplore the lengthening of the formal curricula now characteristic of our undergraduate work. For the latter, greater simplicity of arrangement and thoroughness of teaching in the four year period are the desiderata.

WHAT IS THE MEANING OF THE B.S. DEGREE IN ENGINEERING?

BY H. S. EVANS,

Dean, College of Engineering, University of Colorado.

I have placed a question mark after the subject of my paper, as I am sure any one looking over the catalogues of our engineering schools and colleges would finish the task with a very large question mark in his mind. This would be true for several reasons. In the first place, let the investigator be ever so intelligent and careful in his study, he would fail to discover from the literature of many schools just what is required, and how the various regulations are applied. In common with many in this convention, I have had experience in trying to interpret transcripts of credit for students coming from other institutions, and who wish to enter with advanced standing. In many cases, special letters of interpretation must be requested, and even then many a guess is recorded, with the sincere hope that no injustice has been done either to the cause of engineering education or to the young man who is changing from one school to another. The clearest and most understandable transcript which has come to our office for some time was from the University of the Phillipines. It is significant in this connection that in Dr. Mann's preliminary report a few years ago he says: "We first attempted to collect information on the engineering schools from their catalogues and bulletins, but soon found that it was useless to attempt to find out what the schools were doing in this way. We decided that a personal visit and inspection was necessary."

Next, our investigator would be first surprised and then

* Presented at the thirty-second annual meeting of the Society for the Promotion of Engineering Education, University of Colorado, Boulder, Colo., June 25–28, 1924.

confused and later possibly something worse by the seemingly unjustifiable differences in the required work for an engineering degree. I wonder what would be his conclusions about those of us who are responsible. I should certainly not advocate that every four-year undergraduate course in any assumed branch of engineering should be alike, either in subjects covered or in the number of credit hours devoted to each. Even if all our catalogues should correspond exactly in these respects, it would still be impossible to secure the same results. As long as we have many different personalities teaching the same subjects, and almost as many different ideas as to the standards of excellence which should be enforced—in other words, as long as engineering education depends on human agencies—there must and should be differences in our schools. After admitting that this is so, is it not still true that the present differences are too great to be justified on any reasonable grounds? If we should ask this audience just what should constitute the detailed makeup of a course in any branch of engineering, I have no doubt we should receive approximately as many different answers as there are persons present.

Possibly the differences are not so great as might appear on the surface, however, and possibly we are not unwilling to adjust some of them, if some central agency will help us.

In order to try to show exactly what one engineering school requires for the degree, I had thought to have each department in this College of Engineering write up in considerable detail just exactly what is covered in each individual course. Where problems or drawings or reports were required, representative examples of these were to be included. The whole was to be arranged in order as required for the degree, and printed. I found that neither time nor funds would permit of such an exhaustive study at this time, and possibly the results would not have justified it. I do believe, however, that our ignorance of what other schools are doing, even in subjects of definite name, is much greater than it should be.

We think our courses at the University of Colorado are

good. We point to our product with considerable pride, but we believe that there is always room for improvement. This is evidenced by the fact that we are making slight changes every year; others are often agreed to as being desirable, but are not found to be immediately practicable.

Our requirements for graduation are fifteen acceptible entrance units and two hundred and thirteen term hours (equivalent to one hundred and forty-one semester hours) of college work. This course is as heavy as the average student can possibly carry, and yet there are many subjects omitted which we believe should be included in the ideal training for the embryo engineer. We have asked our advanced students if they would favor a longer course, and almost unanimously they answer "yes." This is one type of evidence for more and better training, but the question is, how much weight should be given to it? Our advanced men have acquired enough knowledge and training to begin to realize how little they actually know, and their desire for a longer course is the most natural expression of this feeling and of their ambition to grow. Possibly the thing they lose sight of when they are seniors, is that their university course is only an earnest attempt to start them on the road to knowledge. Their greatest development should come in the later years, after they drop the rôle of students and assume larger responsibilities. Their answer may also have in it something of the feeling of fear. In most of our schools, the boy—and later the young man—has had the next footprint so clearly marked in front of him all the way that it has become a fixed habit for him to look for it. It may be that he is afraid to step out from our over-supervised educational system.

Our faculties also vote for a longer course, and here again it might not be out of place to inquire if their opinions are always fundamental. It has often been said that we cannot speak without first having the thought back of the spoken word. It is equally true that we cannot form accurate conclusions without having accurate data on which to base our opinions. Our faculties may be living so close to our educa-

tional machine that we sometimes acquire something of the spirit of the advanced student, as interpreted above. Do we sometimes make the mistake of taking ourselves and our opinions too seriously, when our opinions are not based on all the facts?

After all, the *content* and handling of the course is the thing. A well organized and well conducted four-year course will be infinitely superior to a poorly organized and poorly conducted five or six-year course. The length of time a student spends in school is not so important as how he spends his time while he is there. To decide on a five-year course will not in itself solve our problems.

If our non-professional investigator went a little further, what would he find at the end of the course? At the end of the four-year course in schools of apparently the same grade, he would find that almost as many different degrees are being conferred as our engineering educators have been able to persuade themselves to be at least reasonably appropriate. The question of the proper degree to confer on engineering graduates at the end of a four-year course has been before this Society for over thirty years. Many excellent individual papers have been presented on the subject. Excellent committees have worked faithfully on the question, and have presented their reports and recommendations to previous conventions, and their recommendations have been adopted. Foundations have helped finance investigations which have thrown valuable light on this problem. After all this, what is the status of the question as we meet in the thirty-second annual convention of the Society for the Promotion of Engineering Education?

Probably more engineering schools and colleges confer the degree Bachelor of Science in some specific branch of engineering, as B.S. in C.E., for example, than any other one degree—and that is good. In my opinion, it is the reasonable and proper degree to confer at the end of the four-year course. It probably is not advisable to enter into detailed arguments to support that opinion in this paper. But what

do we find when we compare the requirements for the professional degree, C.E., E.E., M.E., etc? With my belief in engineering education and my enthusiasm for all it stands for and is doing, I hesitate to speak of it. Some "A" grade schools confer the professional degree at the end of the four-year course, and from that minimum requirement we progress in other equally "A" grade schools all the way to a requirement of at least ten years of successful professional experience before the professional degree will be granted. In the latter case, this degree is rated as being equivalent to the Ph.D.

If some of the members of this Society feel now as they have expressed themselves in times past, they would answer that this question is unimportant, that it is not fundamental. It is easy to agree that it is not fundamental, if we refer to its relation to the curriculum and the training which a man may receive in his college course. No degree in any branch of learning is fundamental in that sense, but it seems to me that such a wide difference in our opinions and practice is tremendously important, and possibly significant, in its bearing on what has happened and may continue to happen in more important matters. If we cannot get together on this question, how can we hope to avoid the just criticism of those who charge the engineer with a lack of organizing and business ability and various other shortcomings which we are trying to eliminate?

Our investigator would probably have decided by this time that he did not know what the engineering degree means, and that it was impossible, for the present at least, to find out.

Right here it might be well for me to say, in general terms, what I believe the B.S. degree in engineering should mean. I would say it should mean, first, a sound preparatory course equivalent to that offered by a good four-year high school, this course to be as broadly educational as possible, the emphasis being placed on English, foreign languages, mathematics, the fundamental sciences, and history; and next, a four-year university course, where a thorough training is given in the higher mathematics, physics, chemistry, mechanics, English, the

fundamentals of engineering science in its various branches, and, as far as time will permit, survey courses in other branches of the social and economic fields of knowledge.

From what I have been saying, you may have gathered the idea that I am a pessimist. I wish to dispel any such thought, and to say that on the question of engineering education I am an optimist in the terms of any definition which may be applied to the word.

During the past few years I believe a representative portion of the membership of this Society has been having a continuous revival, and this is indeed fortunate, because the judgment day is surely coming, and it behooves us to be ready for it as a profession, rather than for each school to live its own life in isolated contentment.

My plea on this point is that we all try to look for points to criticize in our own courses and for the good points in the courses of our neighbors; that we cultivate an open mind and a willing spirit; and that we persuade ourselves to go a little *more* than half way, if necessary, in the interest of professional progress.

Our Board of Investigation and Coordination, by the terms of the grant of the Carnegie Corporation, is for the present at least engaged upon "a study of the objects of engineering education and the fitness of the present-day curriculum for preparing the student for his profession," and in determining as far as possible "such modifications or developments as would seem to make for a sound, well-balanced and fruitful course of study for engineering students."

Now my further question as a part of the subject of my paper is, what are we going to do about it?

The Committee is the best that could be chosen, the Director has the entire confidence of all of us, and yet in view of past history and of the many things we already know, or think we know without further investigation, it seems to me that the question is entirely pertinent.

Last year we had a most excellent meeting at Cornell on the general topic, "Training for leadership." I had thought

of suggesting for our topic this year, "Training for Action," and with this difference. Last year our whole thought and concern was for the *student,* while this year the subject should apply to *ourselves,* individually and collectively.

Last year, in speaking of the characteristics of engineers, Mr. Wickenden said: "Whatever their preëminence as logicians, engineers have not to my knowledge been very conspicuous as persuaders."

This body has been legislating for thirty years, and every one agrees that much good has been accomplished, but is it out of place to suggest that we should now take on more definite executive functions? Investigation and legislation should always precede execution, but the former is not complete unless followed by results.

I wonder if the teaching profession itself has some unfortunate influence on our problems. Do we get in such a fixed habit of telling our students just what to do and how to do it, and expecting them to believe what we say and act accordingly, that we gradually acquire a portion of the spirit of the dictator? Do we, because we do things a certain way at our own schools, and have the final power to change or not change as we see fit, resent, sometimes unconsciously it may be, any suggestion of interference from an outside agency, even though that agency may be an organization of our fellows?

One of our greatest problems is with those who are interested and concerned in the problems of engineering education, but who do not attend the conventions or take an active interest in this Society. I believe we must have more personal publicity before *all* of our members and even outside of our membership.

One way to accomplish these things is to have our Director and Committee propose some very definite things in a very definite way, and not too many at a time; then to follow up these proposals after they have been approved by the Society by frequent letters of inquiry as to what progress we are making. I am firmly convinced that many of our differences

and deficiencies are not due to fundamental differences of opinion, but are rather due to inertia and neglect. So I should apply the old adage "little drops of water wear away the hardest ivory," and some of us cannot be persuaded in any other way. Most of us hate to admit we are not doing things, while if we did not have to admit it in writing, we should be perfectly content.

If our engineering catalogues and bulletins are so ambiguous and obscure that no one outside of our own immediate faculty is able to interpret them, let us make them universally understandable to outsiders who may be interested. Let us adopt and learn to talk the same language, so that it will not be necessary to send an interpreter along with our literature and our transcripts of credits.

If the content and arrangement of our courses are so much at variance, because they are the work of a hundred independent hands, and no one can tell just what the degree in engineering is supposed to mean, let us get together and show greater unity in method. No one questions our unity of purpose, our earnest desire to secure the best results, and I am sure we can come much closer together than we are now without sacrificing initiative and individuality and those differences which all agree should properly be found in institutions operating under different environment. With our engineering degrees so numerous that their name might be called "legion," let us decide on something that is right for Baccalaureate and for higher degrees, and then all offer them in the class of institutions to which they apply.

Let us try to get down to something definite just as soon as possible, and not mark time until the report of the Committee is completed and such a large program is presented to us that we are more overwhelmed than encouraged to go forward. May it not be possible for us to take some definite action on some definite item or items at this meeting, and then proceed to put them into effect during the coming year, so that at the next convention we can all report "*progress*" along with the

Committee. If we need better methods of choosing our students, and our Director and Committee can recommend what they believe is the best plan, let us adopt it now and proceed to put it into effect. If they can recommend a method or methods of reducing our large mortality among students, why not give it our immediate approval? The same suggestions would apply to any one or more of the important questions which Mr. Wickenden has presented in recent issues of the JOURNAL.

If it is too soon for those who are in charge of the present investigation to make positive recommendations at this time, then I should urge the same action at the first opportunity which presents itself.

The name of our organization is The Society for the Promotion of Engineering Education. I do not think I should wish to suggest that we change the name or the order of the wording, but I should like to urge that we always place the emphasis on the last word, or else that we think of it as the Society for the Promotion of *Education* in Engineering.

So let us try to become not only logicians, but persuaders, not only legislators, but executives, and adopt and put into effect those good things which our Committee and Director will soon propose for us. By this means our Society will make progress and justify its being; but what is even more important is that Education in Engineering will make more rapid strides towards that goal of proficiency which we have set for it.

THE AMERICAN COUNCIL ON EDUCATION.*

BY

PROF. C. J. TILDEN,

Gentlemen of the Society: No one regrets more than I do that Doctor Mann is not able to be here and tell you about his work himself. When he asked me to take his place, however, and describe briefly what the Council has been doing in the last year or two, he knew well of my enthusiasm for the work and the very great privilege that I feel it to be to be associated with him in that work as one of your representatives.

Dr. Mann has published a pamphlet, which some of you may have seen, on the American Council on Education, and he puts the situation with regard to it so clearly in two or three sentences, that I should like to read those: "The American Council on Education is the central organization in which the national associations dealing with higher education are represented. There are many large problems of policy in the domain of higher education. Some demand immediate solution, some are more remote. All emphasize the familiar fact that the development of the American scheme of higher education has been planless, individualistic, in many of its aspects accidental. But unified action has been impossible because there was no unifying agency. The formation of the American Council on Education in 1918 represented an attempt to establish such a unifying agency. The primary aims of the Council have been to stimulate discussion, to focus opinion, and in the end to bring about joint action on major matters of higher educational policy."

The Council is thus seen to be the machinery of the organization of higher education. There are three classes of membership, constituent, associate and institutional. This

* Address delivered at the meeting of the Society for the Promotion of Engineering Education, Boulder, Colorado, June 25, 1924.

Society for the Promotion of Engineering Education is one of the fifteen constituent members of the American Council on Education. The institutional members comprise something over one hundred and seventy institutions of higher education in the United States which contribute from one hundred to five hundred dollars a year for the support of the Council. We, therefore, as a society are giving our support in two ways—the moral support of constituent membership, and a financial support which comes from most of the institutions which are represented in the S. P. E. E. membership.

Among the activities of the American Council, the first to be mentioned is the publication of the *Educational Record*. In that bulletin is given quarterly a resumé of the more specific and definite activities. One of the continuing lines of work is that in Federal Legislation. Through a committee specially charged to look after this subject the Council keeps in close touch with proposed legislative action affecting questions of higher education, bringing it through the Record to the attention of those interested, for discussion and for their information.

A little piece of work—I say "little," because it occupies only a few pages, but it represents a large amount of labor—has just come out in pamphlet form—Standards for Accrediting Colleges, Junior Colleges and Teacher Training Institutions. This is in the nature of an engineering specification of what an institution of higher education should be. The various parts and functions of the institution are listed in sufficient detail so that a pretty clearly defined standard is set up. Under the general head of "colleges," for example, we find the following topics discussed in this way: Admission of Students: Graduation Requirements: Faculty: Income (including material resources in general): Educational Standards. That, I think, is an exceedingly valuable document. It may need to be changed, indeed must be changed to some extent from time to time, but at least it gives a basis of great value in the determination of many of these questions.

Another pamphlet of twenty pages which has just come out is a discussion of education for citizenship. That was reported by a committee of which President Burton was Chairman and Doctor Mann himself, Secretary.

A considerable increase in the activity of the Council has recently taken place along the lines of international education and international educational policies. The Council has for some years had a committee on this subject, but recently—within the last month or two—the scope of its work in this field has been much increased by taking over the work of the American University Union. That organization, which maintains headquarters in London and Paris as well as New York, did much good work during the war and afterwards. Its activities will be continued under the direction of a committee of the Council which comprises practically the membership of the Trustees of the Union. This assimilation of the Union does not mean absorption which will in any sense limit its activities but rather increase them and carry on the policies which were outlined by the original group of the Union, which is now in charge as a Committee of the Council.

A very considerable addition to the funds, available for expenditure in studying this question of international educational relations, and of bringing students from France and England over here, and sending students from the United States to those two countries, has come from the Laura Spelman Rockefeller Memorial, which is matching the Council's income for this purpose, dollar for dollar, up to $35,000 a year for five years. It is going to make possible a large increase in the activity along that line.

There is also maintained at the Council's office in Washington a Personnel Division in which is kept a register of college and university teachers which is available for the use of presidents and executives of institutions who want to find suitable men. It has already been used to a considerable extent, and is an activity of value both to the teachers and to the executives.

As a matter of business, the Council has been spending out of funds provided by its membership approximately $30,000 a year. For this coming year, 1924–25, the Executive Committee has approved a budget which calls for the expenditure of $33,100. That is for the Washington office of the Council, but does not represent at all the total volume of business of the Council.

In looking over the records of the last meeting of the Council which was held in Washington last month, it appears that the grant of the Laura Spelman Rockefeller Memorial for following up the international questions, and other grants to be spent for special purposes by the Council, bring the total for the year just beginning up to $185,000. It is seen, therefore, that the Council is carrying on a substantial and important business activity in the line of higher education.

This Society can, in coöperaion with fourteen other groups with similar aims, sponsor and help to carry out these things. I think that we as a society are very fortunate to be in on an activity of that sort, and it is one of which we can be very proud.

REPORT OF COMMITTEE NO. 21 ON R. O. T. C.

O. M. LELAND, Chairman.

The following tables, showing distribution of senior units of the R. O. T. C., are submitted for the information of the Society. The purpose of these tables is to show the number and location of all the advanced units, together with the enrollments of third and fourth year students in each branch.

TABLE I.

LIST OF SENIOR R. O. T. C. UNITS.

(Numbers show enrollment of seniors and juniors in each unit in the spring of 1924.)

Name of Institution.	Infantry.	Cavalry.	Field Artillery.	Coast Artillery.	Medical.	Engineers.	Signal.	Motor Transport.	Ordnance.	Veterinary.	Dental.	Air Service.
First Corps Area												
Conn. Ag. Coll.	14											
Yale U.			53			22	14		15			
U. of Maine	53											
Boston U.	54											
Harvard U.			82		7							
Mass. Ag. Coll.		31										
Mass. Inst. Tech.				109		95	59		60			95
U. of New Hampshire	26			12								
R. I. State Coll.	29											
Norwich U.		94										
U. of Vermont	78				43							
Total	254	125	135	121	50	117	73		75			95
Second Corps Area												
U. of Delaware	61											
Princeton U.			80									
Rutgers Coll.	44											
Albany Med. School					23							
Coll. of City N. Y.	32											
Cornell U.	41		52		18		25		40	6		
New York U.	43				21							
Syracuse U.	54											
U. of Buffalo					12							
Porto Rico A. & M. Coll.	23											
U. of Porto Rico	20											
Total	318		132		74		25		40	6		

Name of Institution.	Infantry.	Cavalry.	Field Artillery.	Coast Artillery.	Medical.	Engineers.	Signal.	Motor Transport.	Ordnance.	Veterinary.	Dental.	Air Service.
Third Corps Area												
Georgetown U.	47				19							
Geo. Washington U.					49							
Howard U.	75											
Johns Hopkins U.	48				30	16						
St. John's College	26											
U. of Maryland	44											
W. Maryland Coll.	47											
Carnegie Inst. Tech.						54	23	16				
Drexel Institute.	22											
Gettysburg Coll.	23											
Jefferson Med. Coll.					67							
Third Corps Area (Cont.)												
Lafayette Coll.	57											
Lehigh U.	50											
Pa. Mil. Coll.	27											
Pa. State Coll.	78											
U. of Pennsylvania	49				1						33	
U. of Pittsburgh				41	32			23				
Med. Coll. of Va.					0							
Va. Poly. Inst.	68			108		70						
Va. Mil. Inst.	39	62	66			29						
Total	700	62	66	149	198	169	23	39			33	
Fourth Corps Area												
Ala. Poly. Inst.	59		107			60						
Marion Institute	3											
U. of Alabama	44			28		15						
U. of Florida	67											
Emory U.	97											
Georgia Sch. Tech.	61			75			86	32	111			32
N. Ga. Ag. Coll.	27											
U. of Georgia	41	25										
La. State U.	124											
Miss. A. & M. Coll.	100			62								
Davidson Coll.	23											
N. C. State Coll.	87											
Clemson Ag. Coll.	298											
Presb. Coll. of S. C.	42											
The Citadel	52			41								
Wofford Coll.	71											
U. of Tennessee	19					33		13				
Vanderbilt U.					55							
Total	1,215	25	107	206	55	108	86	45	111			32

Name of Institution.	Infantry.	Cavalry.	Field Artillery.	Coast Artillery.	Medical.	Engineers.	Signal.	Motor Transport.	Ordnance.	Veterinary.	Dental.	Air Service.
Fifth Corps Area												
Culver Mil. Acad.	117	20	15									
Depauw U.	36											
Indiana U.	82											
Purdue U.			193									
Rose Poly. Inst.						43						
U. of Kentucky	87											
Denison U.	45											
Mun. U. of Akron	21											
Ohio State U.	79		51		32		78			24	47	
Fifth Corps Area (Cont.)												
U. of Cincinnati				54		26			57			
U. of Dayton	49											
Western Reserve U.					39							
Wilberforce U.	0											
West Virginia U.	28					18						
Total	524	20	259	54	71	87	78		57	24	47	
Sixth Corps Area												
Knox Coll.	29											
N. W. Coll.	41											
Northwestern U.	168										47	
U. of Chicago			37		20							
U. of Illinois	98	77	90			30	27					30
Mich. Ag. Coll.	26	29		56								
U. of Michigan	29			49			17		38			
Ripon Coll.	43											
U. of Wisconsin	65		51				35		21			
Total	499	106	178	105	20	30	79		59		47	30

Name of Institution.	Infantry.	Cavalry.	Field Artillery.	Coast Artillery.	Medical.	Engineers.	Signal.	Motor Transport.	Ordnance.	Veterinary.	Dental.	Air Service.
Seventh Corps Area												
Little Rock Coll.	25											
Ouachita Coll.	38											
U. of Arkansas	52											
Coe Coll.	24											
Iowa State Coll.	41		38			42				12		
State U. of Iowa	43				37	33		26			21	
Fairmount Coll.	26											
Kansas State Ag. Coll.	43			53						20		
U. of Kansas				33		14						
U. of Minnesota	28			33	34		25				54	
Mo. School of Mines						32						
St. Louis U.					47						90	
U. of Missouri	94		57									
Washington U.				27	44							
Creighton U.	31										43	
U. of Nebraska	141											
N. D. Ag. Coll.	35											
U. of North Dakota	74											
S. D. State Coll.	27											
U. of South Dakota	33											
Total	755		95	146	162	121	25	26		32	208	
Eighth Corps Area												
U. of Arizona		38										
Colo. Ag. Coll.			58									
State Sch. of Mines						71						
N. M. Coll. A. & M.	24											
N. M. Mil. Inst.		43										
Okla. A. & M. Coll.	81											
U. of Oklahoma	54		44									
A. & M. Coll. of Tex.	254	75	91				34					32
Baylor U.					21							
Total	413	156	193		21	71	34					32

Name of Institution.	Infantry.	Cavalry.	Field Artillery.	Coast Artillery.	Medical.	Engineers.	Signal.	Motor Transport.	Ordnance.	Veterinary.	Dental.	Air Service.
Ninth Corps Area												
Cal. Inst. of Tech.						37						
Leland Stanford U.			53									
Pomona Coll.	19											
U. of California	57			6	3				7			
U. of Cal., S. Br.	28											
U. of Idaho	50											
Montana State Coll.	17											
U. of Montana	23											
U. of Nevada	8											
N. P. Dental Coll.											83	9
Oregon Ag. Coll.	47	42	41			30		25				
U. of Oregon	39				52							
Ag. Coll. of Utah				5				22				
U. of Utah			40									
State Coll. of Wash.	35					32						
U. of Washington	36			33								19
U. of Wyoming	16											
Total	375	42	134	44	55	99		47	7		83	28
Hawaiian Department												
U. of Hawaii	37											
GRAND TOTALS (Advanced Course)												
Enrollment of Seniors and Juniors	5,090	536	1,299	825	706	802	423	157	349	62	418	217

TABLE II.

NUMBER OF UNITS.

Corps Area.	Infantry.	Cavalry.	Field Artillery.	Coast Artillery.	Medical.	Engineers.	Signal.	Motor Transport.	Ordnance.	Veterinary.	Dental.	Air Service.
First	6	2	2	2	2	2	2		2			1
Second	8		2		4		1		1	1		
Third	15	1	1	2	7	4	1	2			1	
Fourth	17	1	1	4	1	3	1	2	1			1
Fifth	10	1	3	1	2	3	1		1	1	1	
Sixth	8	2	3	2	1	1	3		2		1	1
Seventh	16		2	4	4	4	1	1		2	4	
Eighth	4	3	3		1	1	1					1
Ninth	12	1	3	3	2	3		2	1		1	2
Hawaiian	1											
Totals	97	11	20	18	24	21	11	7	8	4	8	6

Respectfully submitted,

W. N. BARNARD,
C. R. MANN,
A. A. POTTER,
O. M. LELAND, *Chairman.*

CONTINUOUS BEAMS WITH IRREGULAR LOADS.

BY

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Until recently all practical applications of continuous beams involved either uniformly distributed or concentrated loads. The increasing importance of airplane design has made important some other forms of loading which heretofore have been only of academic interest. Most, if not all, of American textbooks on Mechanics of Materials treat only of the two cases mentioned above and say nothing at all of the treatment of loadings of uniformly varying intensity (triangular loading) or other irregular forms. The usual treatment is to derive the two familiar forms of the three moment equation from the differential equation of the elastic curve. This method when applied to other than the two cases mentioned leads to very laborious algebraic work with consequent chance of error.

In certain English textbooks on Mechanics * there is derived a generalized form of the three moment equation which can be simply applied, analytically for most cases and graphically for all cases of loading. It is with the purpose of arousing some interest in this method that this article is written. The equation referred to is derived by the area moment method. It expresses the relation between the moments at three consecutive supports and the moments of the areas of the moment diagrams for the two consecutive spans. The moment diagrams are calculated as if each span were simply supported at its ends.

* Morley, "Strength of Materials," page 216; Low's "Mechanics"; "Airplane Structures," Pipard and Pritchard. None of these give examples of irregular loads, however.

The equation is

$$N_1 l_1 + 2N_2(l_1 + l_2) + N_3 l_2 = -\frac{6A_1\bar{x}_1}{l_1} - \frac{6A_2\bar{x}_2}{l_2},$$

where N_1 N_2 N_3 are the negative moments at the three supports of any two consecutive spans of a continuous beam

l_1 and l_2 are the lengths of the two spans,

A_1 and A_2 are the areas of the moment diagrams for the two consecutive spans, these being calculated as if the spans were simply supported at their ends,

$\bar{x}_1$ is the distance of the centroid of A_1 from the left support of the second span of any two consecutive spans.

x_2 is the distance of the centroid of A_2 from the right support of the second span of the same two consecutive spans.

The following cases of triangular loading will serve to show how easily this equation can be applied.

Given a continuous beam of any number of spans on which the intensity of loading varies uniformly from zero at the left support of each span to K_1 K_2, etc., at the right support of each span.

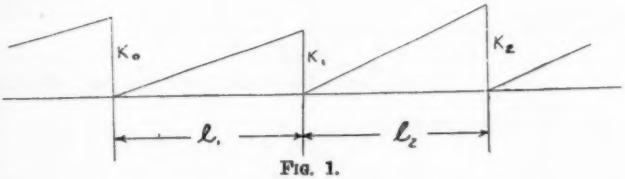

FIG. 1.

Let Fig. 1 represent two consecutive spans.

Construct the Bending Moment diagram for each span as if each were a simple span. (It is not necessary to actually construct the Bending Moment diagram but a sketch of it is useful in what follows.) Since the spans are treated as

simply supported

$$R_1 = \frac{K_1 l_1}{6}.$$

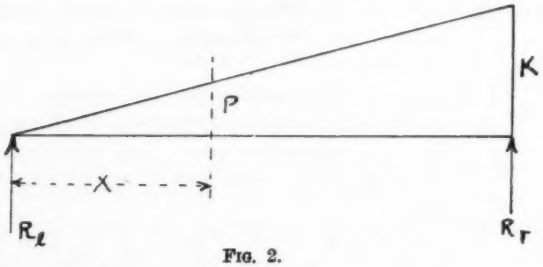

FIG. 2.

Let M_x be the bending moment at any distance x from the left support, then

$$M_x = \frac{K_1 l_1 x}{6} - \frac{K_1 x^3}{6 l_1}.$$

The area of the *B.M.* diagram will the integral of M_x between zero and l

$$A_1 = \int_0^{l_1} M_{x1} = \Big|_0^{l_1} \frac{K_1 l_1 x^2}{12} - \frac{K_1 x^4}{24 l_1} = \frac{K_1 l_1^3}{24},$$

$$A_1 = \frac{K_1 l_1^3}{24},$$

by analogy

$$A_2 = \frac{K_2 l_2^3}{24}.$$

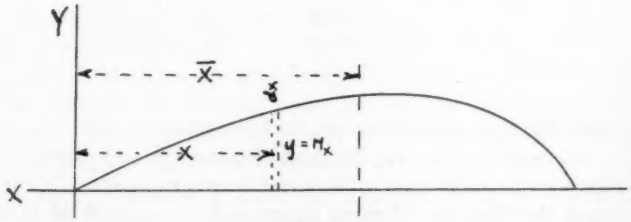

FIG. 3.

The next step is to find the centroid of the *B.M.* diagram. To find $\bar{x}_1$

$$\bar{x}_1 = \frac{\int_0^{l_1} xdxy}{A_1} = \int_0^{l_1} xdx \left[\frac{K_1 l_1 x}{6} - \frac{K_1 x^3}{6 l_1} \right] \Big/ A_1$$

$$\bar{x}_1 = \frac{\frac{K_1 l_1^4}{18} - \frac{K_1 l_1^4}{30}}{\frac{K_1 l_1^3}{24}} = \frac{8}{15} l_1.$$

If $\bar{x}_1 = \frac{8}{15} l_1$ it can be readily seen that $\bar{x}_2 = \frac{7}{15} l_2$.

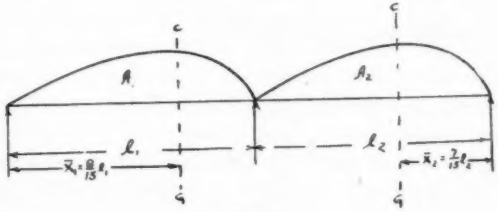

FIG. 3a.

Substituting

$$\frac{6A_1x_1}{l_1} = \frac{K_1 l_1^3}{24} \times \frac{8}{15} l_1 \times \frac{6}{l_1} = \frac{8}{60} K_1 l_1^3$$

$$\frac{6A_2x_2}{l_2} = \frac{K_2 l_2^3}{24} \times \frac{7}{15} l_2 \times \frac{6}{l_2} = \frac{7}{60} K_2 l_2^3$$

and the formula for this loading reduces to

$$N_1 l_1 + 2N_2(l_1 + l_2) + N_3 l_2 = -\left(\frac{8K_1 l_1^3 + 7K_2 l_2^3}{60} \right). \quad (1)$$

If there are only two spans N_1 and N_2 are zero. If there are more than two spans a similar equation must be written for each two consecutive spans and the equations solved as simultaneous.

By inspection it can be seen that if the loading were as in Fig. 4

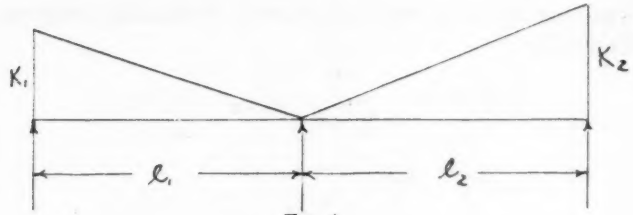

FIG. 4.

the formula for two consecutive spans would be

$$N_1 l_1 + 2N_2(l_1 + l_2) + N_3 l_2 = -\frac{7}{60}(K_1 l_1^3 + K_2 l_2^3) \quad (2)$$

or if the loading were as in Fig. 5

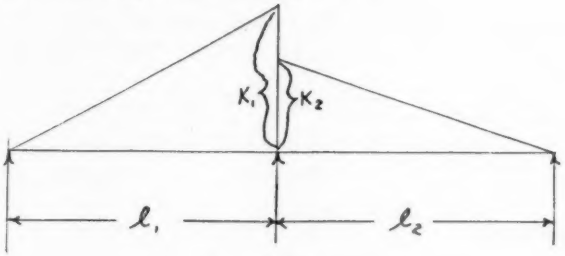

FIG. 5.

the formula for two consecutive spans would be

$$N_1 l_1 + 2N_2(l_1 + l_2) + N_3 l_2 = -\frac{8}{60}(K_1 l_1^3 + K_2 l_2^3). \quad (3)$$

If the loading were as in Fig. 6

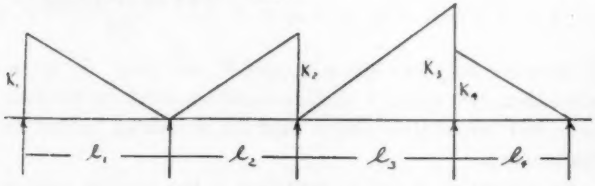

FIG. 6.

the relation between the moments at the various supports could be obtained by writing equation 2 for spans 1 and 2, equation 1 for spans 2 and 3 and equation 3 for spans 3 and 4 and solving these equations simultaneously. Any combinations of triangular loadings on any number of spans may thus be taken care of. The method is also applicable to any form of loading for which it is possible to write a moment equation.

To work the problem shown in Fig. 1 by the usual method would require the writing of the differential equations of the elastic curve for each span, integrating each twice and determining the constants of integration. The equation for the first span would have to be equated to the equation for the second, for appropriate values of the variable. At first glance this may seem easier than the method here presented. However, unless one is gifted with unusual accuracy, a little experience will show that to arrive at a correct result, considerable time is required to deal with the cumbersome equations resulting. Furthermore the additional loadings shown could not readily be solved by inspection.

To apply this generalized equation graphically to any manner of loading the following operations are necessary.

(1) Draw the beam and loading to scale.

(2) Divide the loading into small segments so as to treat each segment as a concentration.

(3) Construct the funicular polygons for each span considered as a simple beam. These will be the moment diagrams.

(4) Using these moment diagrams as loads determine their centroidal distances graphically.

(5) Measure the areas of the moment diagrams with a planimeter and the centroidal distances with a scale, thus obtaining the quantities A_1, $\bar{x}_1$, A_2, $\bar{x}_2$, etc.

(6) Substitute in the general equation as given above.

REPORT OF COMMITTEE NO. 6, SECTIONS AND BRANCHES.

The Committee on Sections and Branches respectfully submits the following report dealing with its activities of the past year:

Under date of October 25, 1923, the following Committee on Sections and Branches was appointed:

H. S. Boardman, General Chairman, and Chairman of District No. 1.
H. E. Dyche, Chairman District No. 2.
R. S. King, Chairman District No. 3.
C. I. Corp, Chairman District No. 4.
F. C. Bolton, H. V. Carpenter, Chairmen District No. 5.

As soon as possible the General Chairman attempted to organize a campaign in the various districts. It appeared that the activities of the Committee could be divided into two parts:

First: The development of Sections and Branches in such locations and institutions as might be possible and feasible.

Second: The gathering of data regarding the activities of the Sections and Branches already in existence, and the stimulation of such branches as might appear to need it.

The reports of the various Chairmen are summarized as follows:

District No. 1.

Questionnaires dealing with the before-mentioned activities were sent to all institutions of collegiate grade in the district. Nearly all of the institutions replied. Several stated that they were considering the establishment of a branch. A large majority, however, stated that they already had organiza-

tions of their engineering college which discussed various problems similar to those which would be taken up by a branch, and they did not feel that a duplicate organization would be successful, and they apparently did not care to change their organization.

The New England Section in this district is an active organization. It holds two meetings a year, one in the fall and one in the spring. The one held last fall was at Rhode Island State College, Kingston, R. I.; attendance 70, with twelve institutions represented. The spring meeting was held at Sheffield Scientific School, Yale University, New Haven, Conn.; attendance 80, fourteen institutions represented.

District No. 2.

A thorough canvass was made in this District similar to that in District No. 1, with about the same results.

District No. 3.

A thorough canvass was made similar to that in Districts No. 1 and No. 2. The Chairman reported that there was apparently no possibility of establishing new sections or branches in this District at the present time.

District No. 4.

No report.

District No. 5.

Plans have been started for a Section to include A. and M. College of Texas, University of Texas, and Rice Institute. No new Branches established.

The following Sections and Branches have reported activities during the year:

Sections.

New England	Pittsburgh
Kansas, Nebraska	Ohio
Minnesota	Texas
Georgia Technology	North Carolina

REPORT OF COMMITTEE NO. 6.

BRANCHES.

University of Colorado	Case School of Applied Science
University of Vermont	Stevens Institute of Technology
New York University	Tufts College
Yale University	Georgia School of Technology
University of Maine	University of Akron
Purdue University	

In addition the following institutions are considering the establishment of a Branch:

Renssalaer
Clarkson College of Technology
Rutgers College

It is, of course, impossible to forecast what influence the activities of the Committee will have in delayed results. It is hoped that the way may at least be opened up so that the next Committee on Sections and Branches may be able to continue the campaign with better success. It should be borne in mind, however, that the majority of institutions appear to have so many activities in the way of various local organizations that they hesitate to take upon themselves new burdens which mean additional evening meetings and hard work for those who undertake the active development of a Branch or Section.

REPORT OF THE COMMITTEE ON ENGLISH.

The Committee on English desires to report that the joint conference at which sixty deans and teachers of English and others interested were present was most profitable. It afforded the Committee an opportunity to hear the deans discuss the place of English in the training of engineering students, the kind of English training most likely to prove effective, and the problem of securing teachers fitted for this task,—subjects which have long been a matter of concern to the teachers of English themselves.

The Committee was in almost continuous session after its arrival in Boulder, and the teachers of English present got together for informal conferences in every possible intermission in the regular session of events. The informal sessions were full of interest and profit for all.

During the year the Committee has been in correspondence with eighty or more of the engineering colleges regarding the status of English teaching and the problems encountered in correlating it with the other work of the college. The material thus accumulated from colleges all the way from Saskatchewan to Porto Rico and Hawaii is being studied with great interest, and on the basis of this study a syllabus is being prepared by the Committee on the teaching of English in the engineering schools. When the syllabus is completed, as it is hoped it may be in the near future, it will not only make available a survey of the status of English teaching in the engineering colleges, but will provide a rich display of material that should prove very significant and very useful.

The Committee desires to express its appreciation of the interest and fine coöperation of the deans and of the administrative officers of the Society in the work it is attempting to do.

Respectfully submitted,

S. A. Harbarger,
W. Otto Birk,
Karl O. Thompson,
F. E. Seavey,
J. Raleigh Nelson, *Chairman.*

OCCUPATIONS OF CHEMICAL ENGINEERING GRADUATES.

BY H. C. PEFFER,

Head, School of Chemical Engineering, Purdue University.

Chemical Engineering is still so new as a profession that few understand clearly the functions of the chemical engineer, and the manner in which his course of training fits him to fulfill the demands made upon him.

The function of Chemical Engineering is to apply engineering principles to any operation in which chemical principles are involved. This definition presents a broad field, and presupposes a broad education. Due to the infinite variety presented by the field of Chemistry, in its applications, it is extremely difficult to specialize along narrow lines. The broad and inclusive training which the chemical engineer receives should therefore broaden his outlook and his opportunities.

The School of Chemical Engineering at Purdue University was founded in 1911. Its graduates now number 331, a sufficient number, with the time elapsed, to afford some idea of the trend of this branch of engineering and its chief fields of activity.

The table which follows was compiled from recent records of the 331 graduates in Chemical Engineering above mentioned.

DISTRIBUTION OF GRADUATES IN CHEMICAL ENGINEERING, PURDUE UNIVERSITY, 1911–1924.

Chemists	
Assistant chief or chief chemist	13
Analytical chemist	34
Research chemist	11
	58—17.52%

OCCUPATIONS OF GRADUATES.

Engineers		
Chemical	44	
Construction	2	
Consulting	3	
Electrical	3	
Insurance	3	
Mechanical	5	
Petroleum, gas and by product	16	
Power plant	4	
Production	11	
Research	12	
Sales	20	
		123—37.16%
Metallurgists		23— 6.95%
Executives		
Assistant manager or manager	13	
Sales manager	11	
General superintendent or superintend't	11	
Assistant superintendent	9	
Department superintendent	26	
Assistant foreman or foreman	5	
		65—19.63%
Business		24— 7.25%
Teachers		11— 3.32%
Graduate Students and Fellows		11— 3.32%
Editorial		1—
Unclassified		15— 4.85%
Total		331

THE DEPARTMENT OF ENGLISH.

In preparing for the conference of deans and teachers of English held at the Boulder meeting of the Society last June, the Committee on English received in the course of the year something over a hundred letters from deans and directors of engineering colleges all the way from Saskatchewan to Porto Rico. These letters are so full of interest and significance for the study which the Committee is making of the status of English in the engineering schools, that it seems worth while to publish a brief digest of the conclusions which may be fairly drawn from the evidence they contain. These conclusions, drawn quite fairly without any preconceptions or prejudices, represent, I believe, the consensus of opinion of the deans who have been enough interested to discuss the matter of student English with the Committee. They indicate real progress in the intelligent handling of this serious problem in engineering education.

1. There is now no longer any need to urge the importance of training in English for prospective engineers.

2. There is almost a universal recognition, that, while the objective is the same and the subject matter the same, the problem of teaching English to engineering students is a real problem, and the students' interests form a strategic point of attack, and a natural motivation for such work. The old jibe at "engineering English" is outworn, having served the double purpose of outlawing that anomalous phrase and necessitating a recognition of why we insist on a study of the teaching problem involved.

3. The requirements in English have doubled in the past ten years, and in many schools are now approaching the possible maximum. In only nine schools is it below six hours, the most common requirement, while in forty-three it goes

above that. Nearly as many schools now require twelve hours as six.

4. The need for more perfect coördination of the work in English with the work in technical subjects is being increasingly recognized. A number of very satisfactory schemes for accomplishing this have been worked out. No less than sixteen schools report progress in this direction.

5. The distribution of the responsibility for training the student to write and speak as an educated man should, is being more fairly placed upon the entire engineering faculty to the relief of an overburdened staff of teachers of English, and to the greatly increased efficiency of the work.

6. There is an increased tendency to teach English to students in special sections, to put such sections in charge of teachers specially interested and specially fitted for this work, and a rapid increase in the number of schools with a separate set of teachers to conduct these classes. Of eighty schools reporting only thirty still maintain the mixed section. Thirty-four have special sections and sixteen separate English departments within the engineering college.

7. The teacher is coming to be recognized as the supreme factor in this problem. This raises a multitude of questions that rather defy answer. From what source shall we recruit our staff? How can we induce men of the best ability and the highest ideals to undertake this work? How shall we retain them in this work permanently so that they may identify their interests with those of engineering education as a life interest?

In looking forward to the conferences of teachers of English at Schenectady next June, the Committee on English would appreciate greatly any comments or criticisms of the outline of the situation given above. The Committee would also welcome suggestions as to the shaping of the program for the proposed conferences. Address the Chairman, J. Raleigh Nelson, 927 Forest Ave., Ann Arbor, Mich.

NEW MEMBERS.

G. C. SHAAD, Chairman.

District No. 1.

HERR, E. M., President, Westinghouse Electric and Manufacturing Company, New York City.

District No. 2.

KUNKEL, GEORGE M., Instructor, Bucknell University, Lewisburg, Pa.

District No. 4.

BENNETT, C. RALPH, Instructor in English, University of Minnesota, Minneapolis, Minn.

CHRISTIANSON, PETER, Professor of Metallurgy, University of Minnesota, Minneapolis, Minn.

CREAMER, JOHN J., Instructor in English, University of Minnesota, Minneapolis, Minn.

FRAUTZ, RAY W., Instructor in English, University of Minnesota, Minneapolis, Minn.

GREY, LENNOX B., Instructor in English, University of Minnesota, Minneapolis, Minn.

HARDER, OSCAR E., Professor of Metallography, University of Minnesota, Minneapolis, Minn.

HARDING, EVERHART R., Associate Professor of Chemistry, University of Minnesota, Minneapolis, Minn.

KUHLMAN, JOHN H., Instructor in Electrical Design, University of Minnesota, Minneapolis, Minn.

LAGAARD, MAURICE B., Assistant Professor of Structural Engineering, University of Minnesota, Minneapolis, Minn.

MANN, FREDERICK M., Professor of Architecture, University of Minnesota, Minneapolis, Minn.

MICHEL, RUDOLPH, Assistant Professor of General Engineering Drawing, University of Illinois, Urbana, Ill.

MOFFETT, JOHN H., Instructor in Foundry Practice, University of Minnesota, Minneapolis, Minn.

MONTONNA, RALPH E., Assistant Professor of Chemical Engineering, University of Minnesota, Minneapolis, Minn.

PARKER, WALTER H., Professor of Mining, University of Minnesota, Minneapolis, Minn.

POTTER, ORRIN W., Instructor, University of Minnesota, Minneapolis, Minn.

RICHARDSON, HARLOW C., Instructor in English, University of Minnesota, Minneapolis, Minn.

THE UNIVERSITY OF WYOMING, Laramie, Wyo. A. G. Crane, President.

SECTIONS AND BRANCHES.

The **Case Branch** of S. P. E. E. held the first meeting of the year 1924–25 at the Case Club on December 16, 1924, with thirty-two members present.

After a cafeteria supper, the meeting was opened at 6:30, with the president, Professor C. L. Eddy, presiding.

Dean Focke was then introduced as the speaker of the evening, his subject being "Placement Tests for our Freshmen." He told of some of the results which had been obtained by the use of intelligence and placement tests for the purpose of determining into what sections the freshman class should be divided. He also presented some charts which compared the training in certain subjects the student had received, to his natural ability in those same subjects.

After a few remarks and questions by some of the members, the meeting adjourned at 7:40 P.M.

W. E. NUDD,
Secretary.

North Carolina Section.—The first meeting of the 1924–25 year was held at the North Carolina State College of Agriculture and Engineering on December 6, 1924, with an attendance of 20. It was devoted to a discussion of the annual convention at Boulder by Professors Riddick and Harrison, both of the State College, who had attended the convention. Dr. Riddick discussed the general work of the convention and considered in some detail Mr. Wickenden's report of the work of the Board of Investigation and Coördination, which he said was "the meat of the convention." Dr. Harrison in his talk gave especial emphasis to the accomplishments of the Committee on English.

The second meeting was held in conjunction with the annual meeting of the North Carolina Section of the American Soci-

ety of Civil Engineers at the University of North Carolina on February 7, 1925. The A. S. C. E. Section had luncheon at one o'clock and their meeting in the afternoon, to which the members of the S. P. E. E. Section were invited. The latter reciprocated by inviting the A. S. C. E. members to dinner at the new Carolina Inn at 6:30 P.M. and their meeting in the evening. At the S. P. E. E. meeting there was an attendance of 30 of whom about 8 were practising engineers and members of the A. S. C. E. Section.

The subject for the evening was "Mathematical Training for Engineers." This was discussed by Dr. William Cain from the point of view of the pure mathematician and by Dr. A. W. Hobbs from the standpoint of the engineering teacher, both of the University of North Carolina. There followed an active discussion in which many of the members participated and also several of the engineers who were guests of the Section for the evening, notably Mr. Charles Waddell who is chairman of the State Board of Registration for Engineers and Land Surveyors.

Other speakers at the meeting were Mr. George T. Seabury, Secretary of the A. S. C. E., and Mr. H. P. Hammond, Associate Director of Investigation, both of whom also spoke at the A. S. C. E. Section meeting in the afternoon. Mr. Hammond gave a brief, but extremely interesting account of the work already done in the investigation.

D. C. JACKSON, JR.,
Secretary.

Purdue Branch.—The Purdue branch of the Society met in the Memorial Union Building on the evening of February 16, 1925, for the second meeting of the school year, with President S. D. Chambers presiding.

Dr. W. K. Hatt, Head of the School of Civil Engineering, gave a very interesting talk upon frequent characteristics of distinguished teachers—viewed from the academic standpoint and without particular reference to the scientific or en-

gineering teacher. The outstanding characteristics mentioned were as follows:

Individuality,
Unworldliness, with idealistic tendencies,
Intellectual balance,
Sympathy with young life,
Scholarly tastes,
The ability to inspire.

He discussed the adjustments of traditions to fit modern education.

The second speaker, Mr. A. P. Strom, of the School of Electrical Engineering, read a paper upon the subject of Technical Education in Sweden, this being followed by considerable discussion with particular reference to comparisons between curricula and teaching methods in the United States and in Sweden and other European countries. Among other matters emphasized in the discussion was the evident high value placed upon the social standing and dignity attached to the professorial position in European Universities.

Meeting adjourned at 9:00 P.M., attendance 35.

G. C. BLALOCK,
Secretary.

BOOK REVIEW.

Electric Cables. By WM. A. DEL MAR. First Edition. McGraw-Hill Book Co., Inc. 1924. 208 pages. 6 x 9.

A book based upon a series of lectures given by the author at the University of Pennsylvania. The theory and application of electric cables is covered in an authoritative manner, providing a text of value to the student and engineer.

NECROLOGY.

George Chandler Whipple, Gordon McKay Professor of Sanitary Engineering at Harvard University.

George Chandler Whipple, son of Joseph K. and Sarah Chandler Whipple, was born at New Boston, New Hampshire, March 2, 1866. He was educated in the public schools of Chelsea, Massachusetts, and was graduated in civil engineering from the Massachusetts Institute of Technology in 1889.

After graduating from the Institute he was employed by Desmond FitzGerald, who, as superintendent of the Western Division of the Boston Water Works, was carrying on some of the earliest American researches into the microscopy of potable waters. Mr. Whipple spent the first seven years of his professional life at the Chestnut Hill Laboratory of the Boston Water Works, studying with meticulous care all the phases of aquatic life in the field and in the laboratory. At the same time he familiarized himself with the chemistry of water analysis and the principles of water purification and sewage treatment which were being developed by some of his Technology associates at the near-by Lawrence Experiment Station of the Massachusetts State Board of Health.

In 1897 he became director of the Mount Prospect Laboratory of the Brooklyn and later New York Metropolitan Board of Water Supply. Here for the next seven years he pursued his favorite study of water biology while attending to the manifold duties concomitant with the administration of a water laboratory equalled in size and volume of work only by that of the Metropolitan Water Works of London. Mr. Whipple's first book, "The Microscopy of Drinking Water," was written during this period. Published at the beginning of the new century, after going through three editions, it still remains the standard textbook on the microscopy of potable water. Another outstanding piece of work of these years was Appendix VI of the Burr-Hering-Freeman Report on the Additional Water Supply of New York City. As department

engineer, Mr. Whipple was in charge of the investigation of the quality of all the sources of water supply considered available for New York City, including the Catskill supply which has since been developed.

In 1904 Mr. Whipple entered private engineering practice with Allen Hazen in New York City. Here, for another seven years, Mr. Whipple was connected with some of the outstanding sanitary engineering work of the time. His most valuable contributions to engineering reports are naturally merged with the work of other members of his firm. Special mention should, however, be made of his studies of typhoid fever and water supply at Cleveland, Ohio; sewage disposal in relation to trade wastes at Paterson, New Jersey, an investigation that necessitated a study trip to England; the soil stripping of large reservoirs in connection with the Catskill supply for New York City; the sewage disposal of Milwaukee, Wisconsin, jointly with John W. Alvord and Harrison P. Eddy; the use of the Rockaway River as a source of water supply for Jersey City. During these years of engineering practice Mr. Whipple was called to testify as an expert on some of the most renowned sanitary lawsuits of the country, including the Chicago Drainage Canal Case and the Passaic Valley Sewerage Case. His book, "The Value of Pure Water" (1907), dates back to this period of his activity.

In 1911 Mr. Whipple was called to the newly established chair of Sanitary Engineering at Harvard University. Always fond of teaching—he had been Professor of Water Supply at the Brooklyn Polytechnic Institute from 1907–11 and had lectured at the Thayer School of Engineering at Dartmouth—Mr. Whipple welcomed the opportunity of returning to New England as Gordon McKay Professor of Sanitary Engineering at Harvard University despite the financial sacrifice entailed. This spirit of service and responsibility to the common welfare is indeed one of the outstanding characteristics of his life.

In 1920, while on sabbatic leave from the University, acting

as Director of Sanitation of the League of Red Cross Societies, he interested the Swiss authorities in the founding of a School of Public Health in Switzerland. A few days before his death a communication from Zurich advised him of the opening of the first Swiss School of Public Health at Basle, a direct result of his efforts.

During the thirteen years that Professor Whipple taught at Harvard his interests, both public and private, were many. To his students he emphasized the ideal of good citizenship and public service and himself practiced his teachings. He served nine years on the Public Health Council of the Massachusetts State Department of Health, refraining from private practice in the State of Massachusetts while he held public office. In 1917 he went to Russia as Deputy Commissioner for the American Red Cross, returning to instruct the Students' Army Training Corps at Harvard. After the war he became connected with the United States Public Health Service (Reserve) as Directing and, later, Senior Sanitary Engineer. Called to the service of the League of Red Cross Societies, the forerunner of the Health Section of the League of Nations, he conducted in 1920 an international investigation into the prevention of the spread of epidemic diseases from Eastern Europe. At home he was called to membership on many important government commissions, such as the International Joint Commission on the Pollution of Boundary Waters, the Board of Excreta Disposal, and the Committee on Official Water Standards of the United States Public Health Service.

In his own institution Professor Whipple served not only as head of the Department of Sanitary Engineering of the Harvard Engineering School but also as the instructor in Municipal Engineering Administration in the Department of Government of Harvard College. When the new Harvard School of Public Health was organized in 1922 Professor Whipple took charge of the courses in sanitary engineering which were offered to a cosmopolitan group of public health students. During his earlier connection with the joint School

of Public Heaith, Professor Whipple volunteered to teach Vital Statistics, a subject not as well formulated then as it is today, but with which he had become familiar when he wrote his book on Typhoid Fever (1908). The lectures thus prepared became a book (Vital Statistics, 1918) which has been translated into several languages, including the Japanese.

At the time of his death he was a member of the General Directive Board of the Committee on Industrial Lighting of the National Research Council. He had recently completed an epoch-making report on plumbing as Chairman of the Sub-Committee on Plumbing of the Building Code Committee of the United States Department of Commerce. He was a member of the Advisory Committee of the Engineering Division of the Regional Plan of New York and Its Environs. He was President of the Anti-Mosquito Association of Massachusetts, Inc., and had served on the Massachusetts Homestead Commission. He had been a member of the Commission on Building Districts and Restrictions of New York, whose work has changed the architectural skyline of New York City. In his own city Professor Whipple had served as Chairman of the Cambridge Sanitary Commission. He was a director of the Young Men's Christian Association, the Anti-Tuberculosis Association, and the Boston School of Physical Education.

Professor Whipple was a member of the American Society of Civil Engineers, American Public Health Association (fellow), American Water Works Association, New England Water Works Association, Boston Society of Civil Engineers (President, 1917–18), American Academy of Arts and Sciences, American Academy for the Advancement of Science. He took a prominent part in the affairs of all these societies and served on their committees or governing boards. He was an honorary fellow of the Royal Sanitary Institute and at one time a fellow of the Royal Microscopical Society. He became a member of the Society for the Promotion of Engineering Education in 1896.